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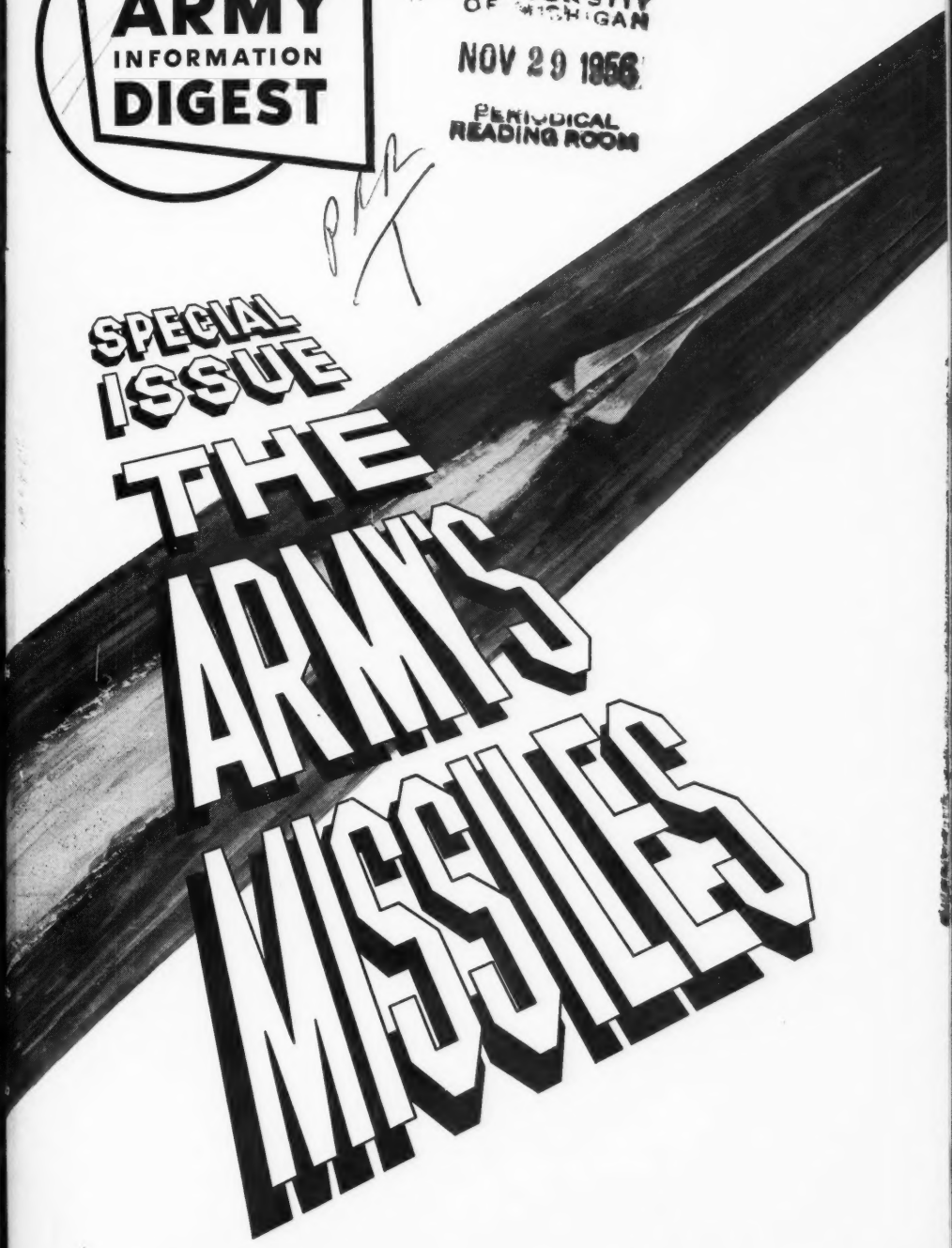

SPECIAL ISSUE

THE ARMY'S MISSILES

THE OFFICIAL U. S. ARMY MAGAZINE

ARMY INFORMATION DIGEST

OFFICIAL MONTHLY MAGAZINE of the DEPARTMENT OF THE ARMY

The mission of ARMY INFORMATION DIGEST is to keep personnel of the Army aware of trends and developments of professional concern.

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IN THE long history of warfare, successive advances in weaponry have sought to deliver firepower of ever-increasing force and effectiveness. In this special issue on Army missiles, high-level Army authorities discuss and appraise the newest additions to Army firepower—their development, principles of employment, impact on tactics and logistics, and implications for the future.

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Volume 11

Number 12

A Special Issue on

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- *The Missiles*
- *The Men and their Training*
- *The Commands*
- *The Future*

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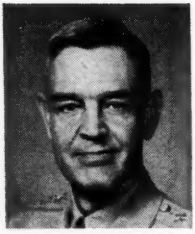

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Enhancing the Army's versatility under all conditions of modern war, missiles provide

ADDED POWER FOR TH

IN THIS NUCLEAR ERA, when our Army must be prepared to fight against any aggressor at any time and under any conditions, flexible mobility and devasting firepower are the order of the day. Both of these essentials are provided in large measure by Army missiles already operational and others under development. Toward an understanding of these revolutionary new weapons—their employment, capabilities, and possible role in future warfare—this special issue is dedicated.

If past history teaches anything, it is the fallacy of relying on any single weapon, tactic, or doctrine as the sole determinant of victory. Accordingly, our Army does not commit itself irrevocably to any one concept, tactical doctrine or any particular family or type of weapons. It recognizes missiles for what they are—a logical extension of the artillery, capable of delivering firepower of ever more devastating force to ever greater distances.

The United States Army pioneered in guided missile, ballistic missile, and rocket development, just as it did in the development of the atomic bomb. Now both missile and bomb in combination are having widespread repercussions on logistics and doctrine of modern war. Some of the implications are discussed by several of the Army's top authorities in this special issue.

Other articles in this issue describe the various members of the Army family of missiles already available and in use today—including the Honest John, Corporal, and Nike. The latter is now the Nation's predominant ground weapon against hostile air invaders, and is rapidly replacing conventional antiaircraft gun batteries guarding our vital industrial centers.

Meanwhile, tremendous forward strides are being made in development of longer-range missiles, such as the Redstone, for which units are even now being organized and trained.

Always, at every stage of development, the emphasis is on accuracy, at whatever distance. Spectacular distances can be readily attained, it is true, but it matters little if at the end of the missile's flight it does not hit the target. Accordingly, all Army research and development is concentrated on attainment of maximum accuracy.

Accelerating step by step, Army research is making a phe-

nomenally rapid transition to the weapons requirements of future warfare. In the development, jointly with the Navy, of the Jupiter, a surface-launched ballistic missile of approximately 1,500-mile range, progress has been speeded by the experimentation and experience already accumulated on the Redstone missile. Thus the Army's missile family continues to grow, each advance an outgrowth of the development which has gone before.

MISSILES and rockets enhance the Army's capability, it is true, but they do not supplant existing weapons of proved worth. From the devastating power of the guided missile with atomic warhead to the sidearm of the MP, the Army must always be ready to apply the proper degree of force with the appropriate weapon, as the situation requires.

The Army therefore must have in its arsenal an adequate variety of weapons which could be used with discrimination against all manner of targets. Missiles add significant power and flexibility to that arsenal.

Always it must be remembered that man himself is the decisive instrument in warfare. In essence, it is the young soldier, possessed of the will and stamina, as well as the weapons and equipment, who must seize and hold ground and deny it to the enemy. In accomplishing this vital, all-important task, the soldier welcomes the newest missile developments as a valuable addition to his arsenal. Besides enhancing his versatility in combat, these new weapons will enable him more readily to push forward to his ultimate goal—victory over any hostile forces theatening his Nation and his liberties.

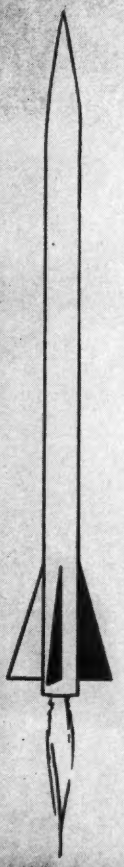
Set in this perspective, the advances in the guided missile field are to be regarded, not as a panacea or a one-shot solution to our Nation's defense requirements, but as a realistic extension of Army mobility and firepower. The missiles described in this issue, in balanced employment with other elements of the Army team, and in conjunction with the other services, will insure a posture of military strength, so necessary to the security of the Nation and of the Free World on which the fulfillment of mankind's hopes depend.—Editor.

THE ROLE OF MISSIL

IN ARMY V

General Maxwell D. Taylor

Chief of Staff, United States Army



ARMY forces have a primary requirement and responsibility for surface-launched missiles employed in support of combat incident to operations on land and in the execution of the air defense mission assigned to the Army. Such missiles are not merely specialized items of equipment; they have broad and general application to land warfare.

All surface-launched missiles which meet Army operational requirements will be developed and integrated into Army forces, as a natural transition from present types of conventional artillery. Army missiles are those ballistic and nonballistic surface-to-surface missiles, and surface-to-air missiles designed to destroy predetermined targets.

All Army personnel must acquire a sound understanding of missiles and their application to ground combat operations. Commanders will exploit the capabilities of missiles in training, planning, and operations.

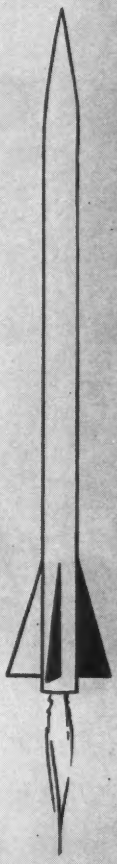
CONCEPTS OF EMPLOYMENT

THE objectives of combat incident to operations on land are to destroy the warmaking effectiveness of enemy forces and to seize and control enemy land areas, installations, and populations. Army forces attain these objectives by maneuver and firepower against enemy troops, materiel, and installations.

The use of atomic weapons in land combat will force

SSILES

MY WEAPONS SYSTEMS



(Note: The essential content of this statement by the Chief of Staff has been promulgated Army-wide in AR 525-30, dated 28 August 1956.—*Editor.*)

greater dispersion of ground forces. The combat zone will be wide and deep; clearly defined lines between battle areas and rear areas cannot be expected.

Army units must be organized for combat, and equipped, to provide improved air defense, increased mobility, and fire support of greater range and effectiveness. The ground commander must be capable of delivering atomic weapons from missiles in a wide variation of ranges and yields.

The effectiveness of Army operations is directly related to the range, reliability, flexibility, and lethality of its close and interdictory firepower. Army missiles with extended range and atomic firepower provide a substantial improvement in ground combat effectiveness. The Army in executing its assigned antiair function provides surface-to-air missile units for the air defense of the continental United States, and of United States overseas bases and forces.

To insure effective response to the air defense and fire support requirements of Army force commanders, Army missile units are employed in general consonance with the accepted principles of artillery fire support as modified by the special characteristics of the missile units. The artillery commander at each echelon is responsible to his immediate Army force commander for command and control and for basic recommendations concerning the employment of Army missile units.

REQUIREMENTS FOR ARMY MISSILES

IN ORDER to fulfill their assigned roles and missions, all services have requirements for missiles integral to their weapons systems. In support of its requirements, the Army has developed and placed in general operational use ballistic and nonballistic surface-to-surface missiles, free rockets, and surface-to-air missiles. The Army has acquired developmental, training, and operational experience on which to base the development and employment of improved surface-launched missile systems which conform to Army requirements and missions. Surface-to-surface and surface-to-air units have been organized under approved tables of organization and equipment, have been trained, and have been assigned operational missions in the active Army.

The Army's *surface-to-surface missile* requirements include—

(1) *Short-range.* Assault or demolition guided missiles to be used against personnel, armor and fortifications.

(2) *Medium-range.* Missiles to supplement and extend the range or firepower of artillery cannon, to provide close or interdictory fire support for ground combat forces, and to compensate for the expanding dimensions of the battle area.

(3) *Long-range.* Missiles capable of supporting Army operations, from protected and widely dispersed rear areas; and of delivering accurate fire on distant targets which are capable of affecting the execution of the Army's combat mission.

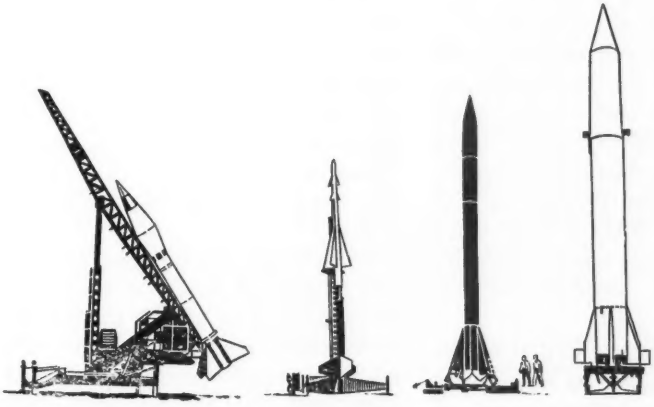
The Army's *surface-to-air missile* requirements include land based antiair missiles for defense against high, medium, or low altitude aircraft, drones, or artillery missiles. Surface-to-air missiles should also have a surface-to-surface role when feasible.

COMMAND RESPONSIBILITIES

THE Commanding General, Continental Army Command, is responsible for the development of training programs and tactical doctrine for Army missile units. The Commanding General, Army Antiaircraft Command, commands all surface-to-air missile units now deployed in defense of the continental United States, and is responsible for developing and coordinating plans for the employment of these units in implementing the continental air defense mission. The Chief of Research and Development, Department of the Army, has the mission of research and development on a priority basis to attain increased Army missile capabilities.

II. The Missiles

"In support of its requirements, the Army has developed and placed in general operational use ballistic and nonballistic surface-to-surface missiles, free rockets, and surface-to-air missiles."



Planning, foresight and concerted scientific effort highlight the recent history of

Army Missile D

Major General H. N

ON 6 SEPTEMBER 1944, the first tactical V-2, Hitler's celebrated vengeance weapon, was launched by German forces from the outskirts of The Hague, Netherlands. At 1843 hours, less than six minutes after it had been fired, the forty-six foot long rocket bearing its 2200 pounds of explosives detonated with devastating effect at Chiswick-on-Thames, near London.

This heralded the most dramatic application of military rockets known to the world. In the next ten days twenty-six V-2's were showered on London. Approaching its target at speeds greater than sound, the V-2 gave no advance warning. For seven months, until 27 March 1945, this bombardment continued. All told, about 1500 V-2's crossed the Channel, 1115 dropping in England. London recoiled under the impact of 518 of them. Nearly 3000 civilians were killed; thousands more were injured. Property damage was tremendous.

Recognizing the potential of the V-2, no less a military leader than General Dwight D. Eisenhower has written: "It seemed likely that, if the German had succeeded in perfecting and using these new weapons six months earlier than he did, our invasion of Europe would have proved exceedingly difficult, perhaps impossible."

The rockets of World War II represented the modernization of a very old weapon. As early as 1232 A. D. defenders of the Great Wall of China launched rockets against the invading hordes of Mongolians. The news spread around the world, and during the 14th Century rockets were used in Europe as an incendiary and terror-provoking weapon. After 1500 A. D. with the development of cannon, the military lost interest in rockets until late in the 18th Century when the Maharaja of Mysore used them effectively against the British in India.

There is no quicker way to stimulate interest in a new weapon than to discover it in use by the enemy. It was not surprising that the British then tried to produce rockets of their own; but it took until 1805 before Sir William Congreve de-

MAJOR GENERAL H. N. TOFTOY is Commanding General, Redstone Arsenal, Huntsville, Alabama.

Development

H. N. Toftoy

veloped rockets considered satisfactory for military use—just in time for the Napoleonic Wars.

During the War of 1812, Americans learned the effectiveness of Congreve's erratic rockets, when with flanking rocket fire the British demoralized the raw militiamen defending Washington and were able to enter and burn our National Capitol. The expression "and the rocket's red glare" immortalized in our National Anthem was not a figment of a poet's imagination—it was the real thing.

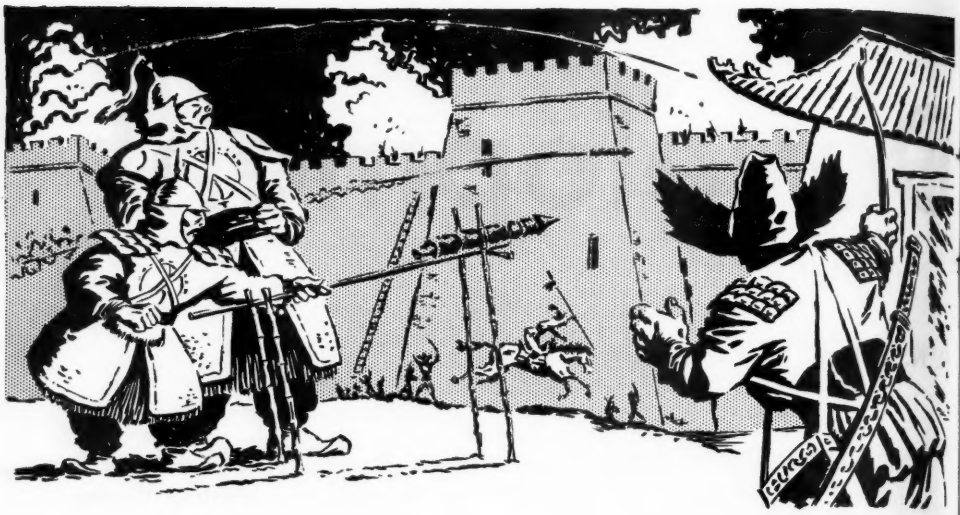
The U. S. Army organized its first rocket battery in 1846. At this time America made its first contribution to improved rocket design. William Hale first produced a spin-stabilized rocket by substituting canted fins for a stabilizing stick. These forerunners of the modern rockets were used in the Mexican War; but in spite of a promising start, they could not compete with the accuracy of rifled cannon introduced in 1860, and once again rockets fell into disuse.

THE Army's interest in rockets reappeared briefly in World War I when Dr. Robert H. Goddard of Clark University, the father of modern rocketry, undertook the development of military rockets. Dr. Goddard developed a number of test models and demonstrated them at Aberdeen Proving Ground, Maryland, on 10 November 1918 before representatives of Ordnance Corps, Signal Corps, Air Service and others. The demonstrations were considered quite successful, and interest was expressed in continuation of the work. On the following day, however, the Armistice was announced, and official interest in military rockets lagged for more than 20 years.

Working under an $11,000 grant by the Smithsonian Institution, Dr. Goddard is credited with developing many of the basic concepts in rocket and jet propulsion engineering. By 1920 he had obtained a Daniel Guggenheim grant, augmented by funds from the Carnegie Foundation, and proved his theories by successfully firing a liquid oxy-

(Continued on page 20)

FOR A PICTORIAL REVIEW OF HIGHLIGHTS OF MISSILE HISTORY SEE PAGES 12-19.



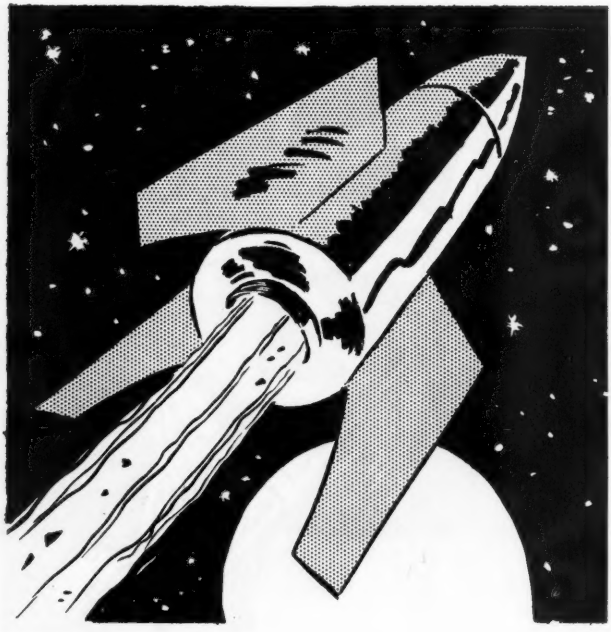
Called the "flaming fire arrow" by the Chinese, rockets in warfare antedated invention of gunpowder. First recorded use was in 1232 A.D. during Mongol siege of Pienking.

Hindu troops defending Seringapatam (1792) fired over 100,000 rockets, powered by black powder and mounted on 10-foot poles, against British. The British quickly adopted weapon and turned it against defenders to capture the city.

From China, knowledge of rockets spread to Arabs, thence to Byzantine Empire. They were used mainly at sea where rigging of sailing vessels offered inflammable targets.

Early experiments in rocketry were pioneered in England by Colonel (later Sir) William Congreve in early 1800s. His rockets reached range of 2000 yards. Later models used a 32-pound rocket with 15-foot guide stick as stabilizer.

British employed improved rockets in bombardment of Boulogne (1806). Copenhagen was almost completely destroyed in 1807 by a deluge of 25,000 rockets. British Rocket Corps won distinction during Battle of Leipzig (1813) which broke Napoleon's power.

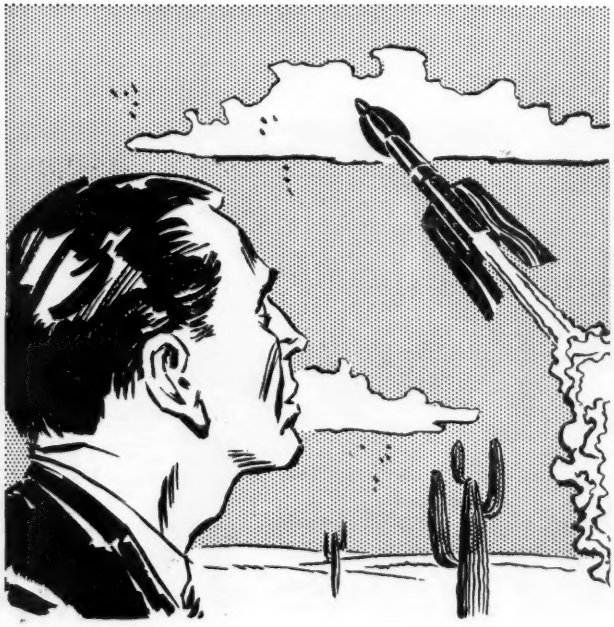


Rocket design was notably advanced by William Hale who introduced metal vanes in lieu of guide stick. Stabilizing spin induced by vanes increased accuracy. Hale rockets were used by U.S. in Mexican War.

British used rockets against U.S. forces defending the Capital at Battle of Bladensburg (1814). Action against Fort McHenry in War of 1812 led Francis Scott Key to write of "the rockets' red glare" in our National Anthem.

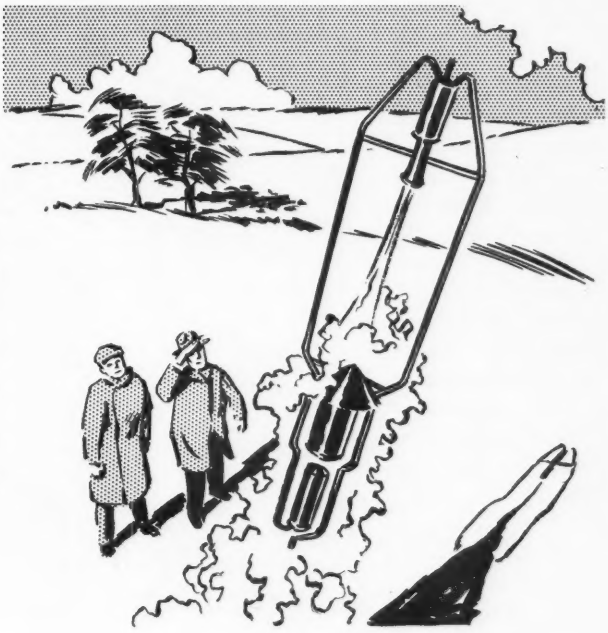
Improvements in artillery led to eclipse of rockets in warfare after 1850. From then on, chief use was as fireworks, signalling devices, or to carry lines to shipwrecked vessels.

In World War I, Germans used gunpowder rockets to destroy barbed wire defenses. French and Russians fired rockets from airplanes to ignite German observation balloons.

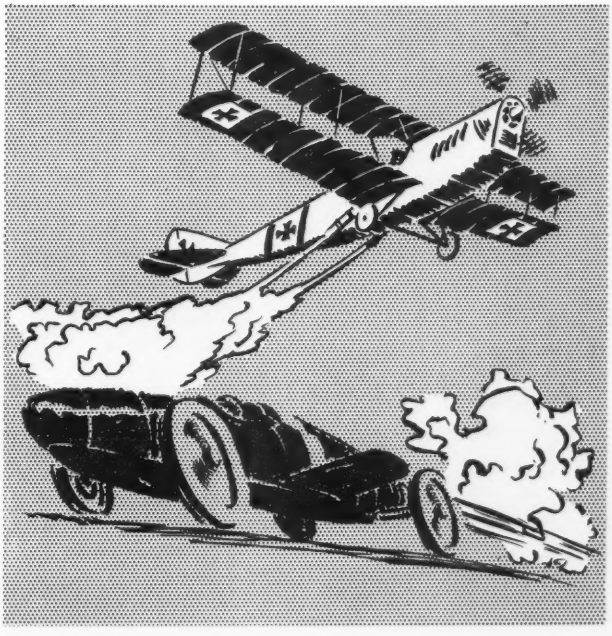


At Dr. Goddard's Roswell, N. Mex., laboratory, many short-range, low altitude flights were made, employing jet vanes with a type of gyro reference, akin to that later used in V-2s. Modern rocketry is largely based on Goddard's experimental work.

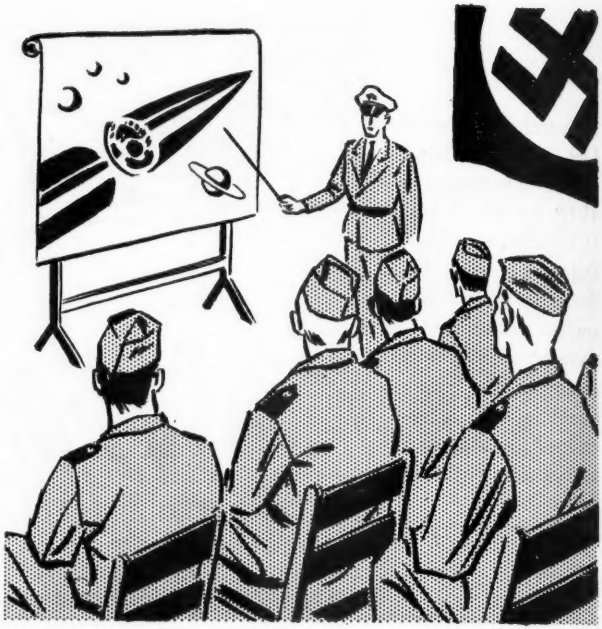
Research on a solid-fuel, multiple-charge rocket was begun in 1916 by Dr. Robert H. Goddard of Clark University, Mass. Under grant from Smithsonian Institution, he developed a controllable rocket using gasoline and liquid oxygen, making first successful flight in 1926.

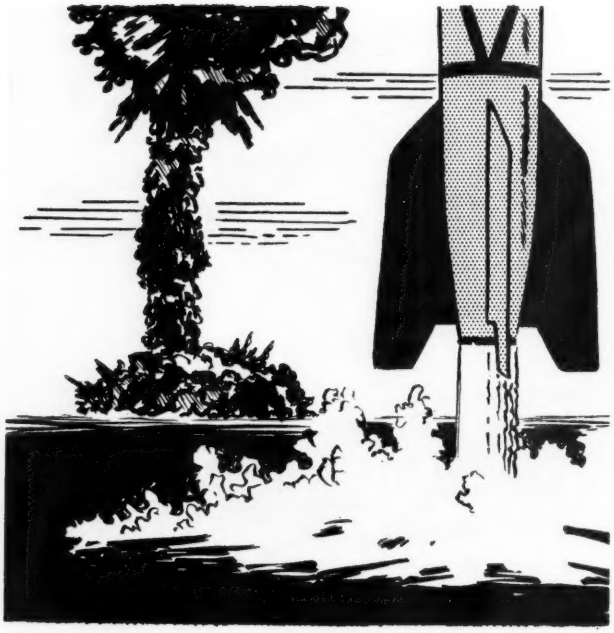


In post-World War I era, Fritz von Opel, Max Valier and other Europeans experimented with rocket powered racing cars and airplanes. Prof. Hugo Junkers developed the jet assist take-off (JATO) employing powder rockets.



German interest in rockets was sparked by Prof. Herman Oberth, a Rumanian, who published "By Rocket to Planetary Space" in 1923. Amateur enthusiasts formed a "Society for Space Travel." But with accession of Hitler, German Army moved in and took over.

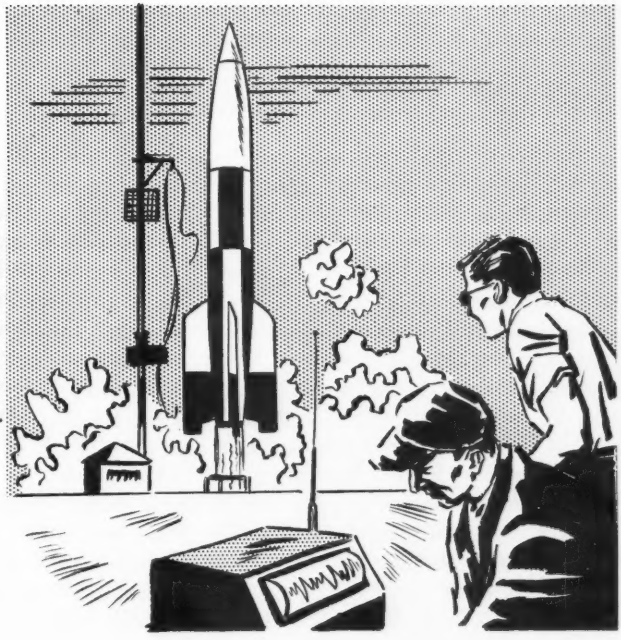




In long range significance, the Peenemunde rocket research effort has been ranked second only to the U.S. Manhattan Project which developed atom bomb—both in size, cost and importance of results.

Germans established research center at Peenemunde on North Sea in 1936. By 1944 V-1 buzz bombs and V-2s were developed. Fired against London, they came perilously close to altering war's outcome.

Today the United States, employing many of the original German scientists at the Army's Redstone Arsenal, is inheritor of and chief pioneer in missile technology.



(Continued from page 11)
gen and gasoline propelled rocket to a height of 7,500 feet with a maximum velocity of 550 m.p.h. Goddard patented a number of fundamental principles which have subsequently been developed for use on present day guided missiles. Among these were the use of fuel to cool rocket motors, jet vanes and gyroscopic control for maintaining stability, and a plan for multi-stage rockets.

Thus the United States, contrary to popular belief, was actually the first to clearly outline the basic principles that were later applied to guided missile development. Germany's experiments with liquid propellant rockets in the early 1930's were generally unsuccessful, but ironically, the Germans developed the first long-range tactical missile and used it against the Americans and their allies.

While Goddard was working on his rockets in 1917 the earliest recorded guided missile project was established. Under direction of Charles F. Kettering of General Motors, the Army Air Service experimented with a remotely controlled pilotless aircraft type of "flying bomb." By 1924 a number of successful flights had been achieved and hits scored as far as ninety miles away.

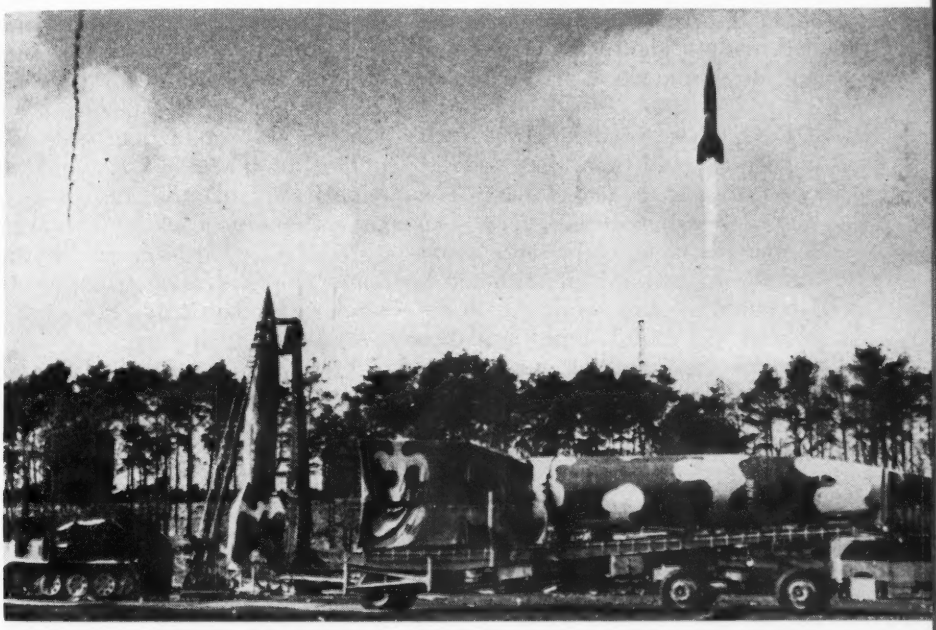
The secret of the flying bomb was almost revealed when one crashed. Local farmers were first on the scene and were mystified when they searched the wreckage and found no pilot. But soon an Army flier, wearing flying togs, arrived and managed to keep the Army secret by claiming he had bailed out back yonder. The farmers did not know that the Army Air Service at that time had no parachutes!

LITTLE was accomplished in the 1920's but in the 1930's European nations carried on secret development of solid propellant rockets for possible tactical application. In the United States, Captain Leslie A. Skinner of the Army Ordnance Corps (now Colonel, Retired) held such a firm belief in military rockets that on his own initiative he carried on experiments in the basement of his quarters at Aberdeen Proving Ground. The Commanding General, fearful that Skinner would wreck the quarters, provided shop space and a few hundred dollars. This effort paved the way for the "bazooka," a weapon which for the first time enabled an infantryman to combat a tank single-handedly.

Every major participant in World War II used rockets. The Russians pioneered in massed rocket barrages and the firing of air-to-ground rockets. The British first used rockets for air defense. The Japanese used them as artillery. The United States, too, developed and introduced rocket weapons. Not a service rocket was available at the time of the attack on Pearl Harbor, yet by V-J day millions of rockets had been produced and fired by our soldiers, sailors, airmen and marines.

The development job was difficult and time-consuming because each project required preliminary development of fundamental knowledge—a step which a continuing peacetime research program would have provided in advance. It is a tribute to the determination of our Nation's Ordnance-Science-Industry team that, starting with such

a handicap, they were able to produce a variety of free flight rockets which sank submarines, defeated tanks, spearheaded the air support for the Normandy breakthrough, and effected a deadly softening up barrage ahead of our forces invading Africa, Sicily, Italy, Normandy and Southern France. Rockets also were used in virtually every Pacific action from Arawe to Okinawa.



A captured German photo shows a V-2 launching site—one missile is being fired, another being prepared, a third is on a mobile trailer.

IN August 1943 a radio controlled glide bomb launched from a German airplane struck a British ship in the Bay of Biscay. This marked the beginning of guidance for missiles in warfare—a principle which, when combined with jet propulsion, led to guided missiles.

The Germans were first to accomplish this, bombarding British cities with the V-1 buzz bomb starting in June 1944 and with the V-2 missile in September of that year. The relatively slow V-1, a 400 m.p.h. pulse jet, utilizing pre-set guidance, was effective enough to cause employment of heavy Allied air defense against it. On the other hand, there was no countermeasure against the 3,500 m.p.h. pre-set V-2 once it left its launching site. Germany demonstrated that the V-2 was an all-weather, day-or-night weapon, effective without the necessity of air superiority.

By the spring of 1945, fifteen thousand V-1 buzz bombs and over 2,500 V-2 rockets had been fired in combat. At war's end, the Germans were developing surface-to-air guided missiles that later might have seriously hampered

Allied bomber operations. They were also busily engaged with improved versions of the V-2.

The Germans were years ahead in the development of modern guided missiles. However, by the time the V-1 and V-2 appeared on the scene, America already had recognized the great prospects for these weapons of the future and had made a good start in research and development.

ONE phase of this activity was concerned with the development of a series of guided bombs. The Armed Services, the National Defense Research Committee and various industrial contractors collaborated in this work which included command type guidance systems incorporating heat, light, or radar seekers. There was even one application of television—long before TV become commercially available.

Best known of these weapons was the Army Air Force's Azon and Razon and the Navy Bat. The Azon was a 1,000-pound general purpose bomb which could be controlled in flight to the right or left by radio. Controlled in azimuth only, it was used for special missions against long narrow targets in Europe such as the locks of the Danube, viaducts near Brenner Pass, the bridges over the Seine. Good results were also obtained in disrupting communications in Burma.

The Razon, which was designed to be controlled in both range and azimuth, was not perfected in time for operational use in World War II. The Bat, the world's first target seeking missile, was pushed to completion and successfully employed against Japanese shipping before the cessation of hostilities. This weapon was a winged glide bomb utilizing radar techniques to home on its target.

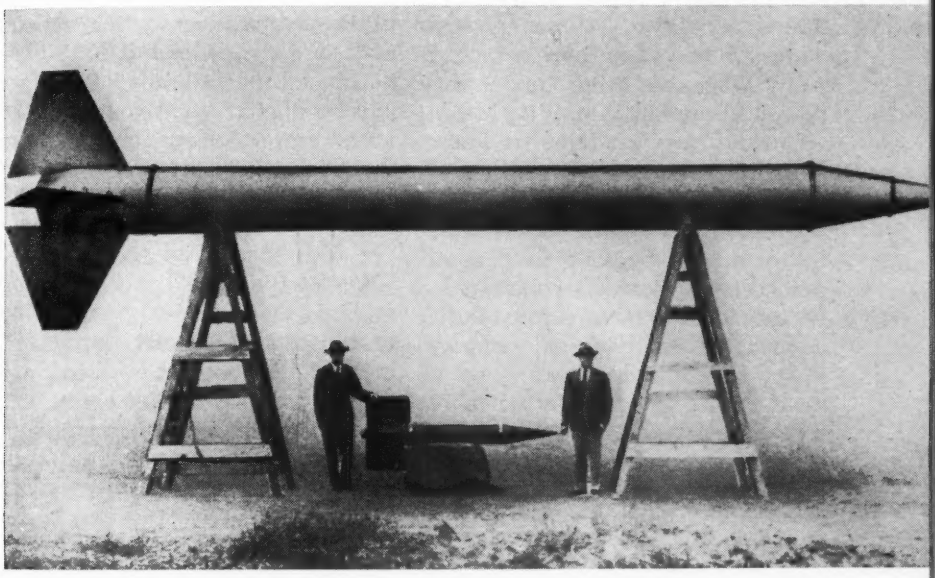
As early as 1941 proposals had been advanced to develop a V-1 type of missile, but it was not until the buzz bomb attacks on England that the War Department initiated this project. Known as the JB-2, or Loon, this 450 m.p.h. pulse jet was similar to the German V-1. Large-scale production was well underway when V-E day led to cancellation of a large portion of the procurement order. The available JB-2's were then used by the three services for experimental work and for training.

THE Army's rocket activity assumed a new status in September 1943 when the Technical Division of the Office, Chief of Ordnance established the Rocket Branch. This new organization indicated that rockets and guided missiles were now considered members of the Army's family of weapons which would be centrally managed in the same manner as small arms, artillery, ammunition and tanks.

At the same time, Ordnance requested the Jet Propulsion Laboratories (JPL) operated by California Institute of Technology to investigate the feasibility of developing long-range surface-to-surface guided missiles. The Ballistic Research Laboratory (BRL) at Aberdeen Proving Ground also was asked to prepare a study in this field. Both the JPL and BRL reports were favorable. Impressed, Ordnance in May 1944 placed a $3,300,000 contract with JPL for general research on guided missiles,

with emphasis on rocket propulsion and supersonic aerodynamics. Known as ORD-CIT, this is the oldest of the Army's continuing missile projects.

In less than a year, early experimental work at JPL confirmed the feasibility of guided missiles and two more contracts were negotiated—the Hermes project with the



A mockup of the Corporal E on supports is displayed above a model of the Private A at the Jet Propulsion Laboratories in May 1944.

General Electric Company, encompassing research and development leading to long-range, surface-to-surface, and to high altitude antiaircraft missiles; and the Nike project initiated in February 1945 with Bell Telephone Laboratories of the Western Electric Company, covering research, development and engineering work required to produce a suitable antiaircraft missile system.

By virtue of its years of aerodynamic work in development of projectiles at Aberdeen Proving Ground, as well as its long experience with complex fire control systems, the Ordnance Corps was well qualified to conduct the Army guided missile program. Even so, Ordnance scientists recognized that they would be pioneering in a considerably broader field than ever before, and that new development and test facilities were essential before progress could be made.

PRIOR to 1944, there was no supersonic wind tunnel of useful size in the United States. Upon the advice and recommendation of some of America's foremost scientists—notably Professor Theodore von Karman, of the Scientific Advisory Committee of BRL, and a special National Academy of Sciences committee headed by Dr. Frederick W. Durand—the necessity

for such a tunnel for research in supersonic aerodynamics was established, and funds were authorized for its construction.

Put into operation late in 1944, the BRL wind tunnel proved invaluable in the solution of supersonic flow problems and design of guided missiles for the Army, Navy and Air Force. For some time it was the only such supersonic wind tunnel available in the United States. Four years later a second Army Ordnance wind tunnel was placed in operation at JPL. Meanwhile the Navy and the Air Force had also built new supersonic wind tunnels.

From the outset of its research, the Army was thinking in terms of guided missiles which would greatly extend the range of artillery; in fact, the Army's initial program included preliminary work on a missile with a potential range of several hundred miles. It was evident that a much longer test range than any previously conceived had to be established immediately. The recovery of spent missiles for study during the development phases was also considered essential. An overland range was therefore decided upon.

Following an extensive survey, the White Sands Proving Ground (WSPG) was established in 1944 in the New Mexico desert 28 miles from Las Cruces and adjacent to the Fort Bliss military reservation. The range extended north approximately 125 miles and was 45 miles wide.

Army Ground Forces (now Continental Army Command) was quick to appreciate the lead time required to develop and evolve doctrine for tactical employment of guided missiles. To insure that trained troops would be available to place guided missiles in operational use as soon as such weapons became available, the 1st Guided Missile Battalion was activated in October 1945 at Fort Bliss. Its members assisted in missile launchings at White Sands, and gained valuable experience long before the first missile system was delivered to them. Concurrently, the Antiaircraft Artillery School at Fort Bliss developed guided missile courses and conducted intensive training of ground forces personnel to prepare them for what was to come.

Having established projects with highly qualified contractors, and provided them with the necessary "tools of the trade" and a proving ground, the Army was now *really* in the guided missile business.

THE Army was quick to utilize the achievements of German scientists and engineers. After Germany's surrender to the United States forces, Ordnance Technical Intelligence personnel recommended transfer of the cream of the crop to the United States in order that the American program might benefit from their knowledge and push onward where the Germans had left off. This Ordnance proposal was approved in June 1945, and under it an integrated team of 130 outstanding key specialists accepted an offer to come to the United States.

Established at Fort Bliss, the group rendered valuable service in indexing and translating large quantities of captured documents, identifying rocket materiel, and assisting with the assembly and firing of V-2's at White Sands.

Their studies and recommendations proved most helpful, not only to Army personnel and contractors but to Navy and Air Force researchers as well. The group was later transferred to Redstone Arsenal after it became the Army Ordnance center for rockets and guided missiles, and their work there has continued to be outstanding. Many are now highly respected citizens of their community and of the United States.

At the beginning of the Army Ordnance missile program, it was realized that in pioneering in a field entirely new to U. S. technology, the frontiers of basic science would have to be advanced. And they were—at an unprecedented rate. During the period the Army was learning to walk before it ran, great technological progress was achieved. Basic information developed at the various Army projects and proving grounds, was made available to all agencies and scientists participating in the national program.

CONSIDER what a guided missile is required to do—fly at thousands of miles an hour speed through the atmosphere and into the vacuum of upper space, navigate itself long distances with practically pinpoint accuracy, and stand up under tremendous extremes of acceleration, vibration, temperature and sudden forces of external disturbances.

Developing such a guided missile system is not a one-man job. Indeed, no other single development to date has been as complex or as difficult. Outstanding experts in electronics, aerodynamics, physics, chemistry, meteorology, mathematics and many other fields of science are required to collaborate as a team in its development.

The carefully planned long-range research and development program which was initiated, was a form of "casting bread upon the waters," for its returns were many fold. At the outset, practically nothing was known about supersonic aerodynamics, the sound barrier, or thermal barriers. There were no textbooks on these subjects—no courses in educational institutions.

NEVERTHELESS, in the fall of 1945, at White Sands Proving Ground, JPL fired the first Wac Corporal to an altitude of 43 miles. From this first American liquid propelled supersonic rocket several important applications evolved. The Navy's Aerobee upper-air sounding rocket was itself a scaled-up version. Principles developed on the Wac Corporal were applied to the Corporal. But the most historic achievement of the Wac Corporal was the part it played in February 1949 as the business end of the Bumper missile, which set altitude and velocity records which still stand.

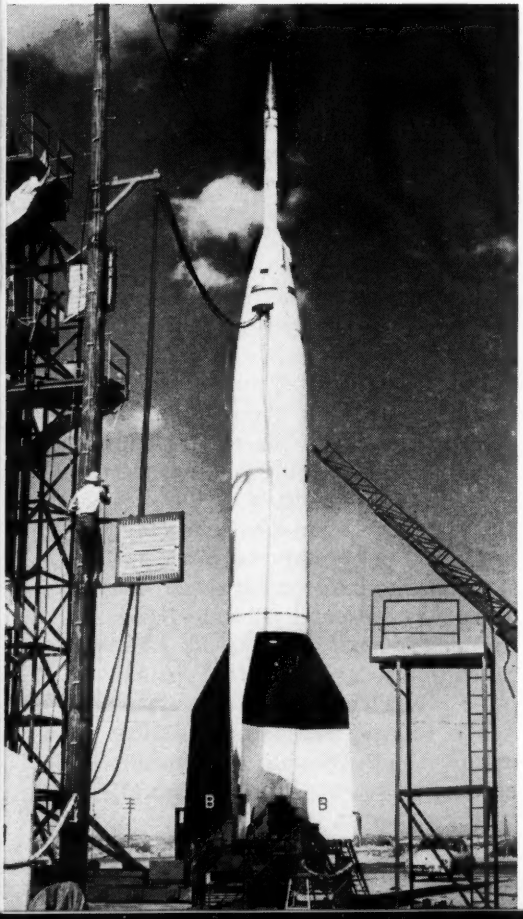
The Bumper itself came about from the need to check theories and provide data on multi-stage rocket flight including (1) the separation and ignition of the second stage rocket in highly rarefied air, (2) the stability of a second stage missile launched at extremely high velocities and altitudes, (3) the aerodynamic effects at high Mach numbers obtainable in no other way at that time.

The Bumper missiles, consisting of a V-2 with its nose modified to accommodate a Wac Corporal,

represented the combined efforts of Army Ordnance, JPL, Douglas Aircraft and General Electric. The first full-powered flight was entirely successful. The Wac Corporal traveled upward at a speed of 5,000 m.p.h. to a height of 250 miles. Thus the Army was first to send a man-made object outside the earth's atmosphere. The flight lasted 12 minutes, necessitating a directional correction of several miles to adjust for the earth's rotation.

The V-2 program conducted at White Sands Proving Ground contributed much to the rapid postwar progress in the missile field. Starting in May 1946, a total of approximately 80 were fired. These were assembled from captured components, with shortages supplied from the Hermes project. The V-2, which stands as a milestone in man's technological progress, was thoroughly researched; in the process it provided considerable background scientific knowledge of value in handling and firing large missiles of this type. Its use as a vehicle for flight testing various components of missiles under development, and for checking out the complex range instrumentation at the proving ground, represented a great saving of time and money. An appreciable number were fired in collaboration with scientific institutions seeking data on the upper atmosphere and the effects of cosmic radiation. In fact this phase became so important that the Navy was authorized to develop its Viking missile to continue the work after the supply of V-2s was exhausted.

This Bumper missile was fired to a record altitude of more than 250 miles during early tests in 1949 at White Sands Proving Ground.



In 1947 the Army cooperated with the Navy in the experimental firing of a V-2 from the deck of the U.S.S. *Midway*. The missile, which had not been designed to counteract a ship's motion at launching, took off in an erratic manner; however, it did prove that large ballistic missiles could be successfully launched from ships.

One V-2, in its role of a flying laboratory at White Sands Proving Ground, almost created a serious international incident. To check on the effectiveness of a ramjet diffusor under actual flying conditions, a V-2, with the ramjet component mounted on its nose, was pro-

grammed for a relatively short flight at low altitude.

The missile took off, rising majestically and properly inclined into its trajectory, but failing to respond to its preset flight path, it headed south instead of north! Radars lost it crossing the Mexican border! It passed over El Paso and over Juarez where a fiesta was in progress. Fortunately it impacted on a barren hill, causing no damage or injuries except those resulting from traffic accidents in the rush to the scene. Enterprising Mexicans roped off the crater, charged admission, and sold bits of the V-2 for souvenirs.

As a result, White Sands operations were ordered suspended until a complex and effective safety system was devised, consisting essentially of a combination of radar tracking with automatic plotting boards, precise and continuous electronic impact prediction, backed up by visual observation through a sky screen on which safety limits were indicated. This insured that missiles would never again cross the boundaries of the proving ground.

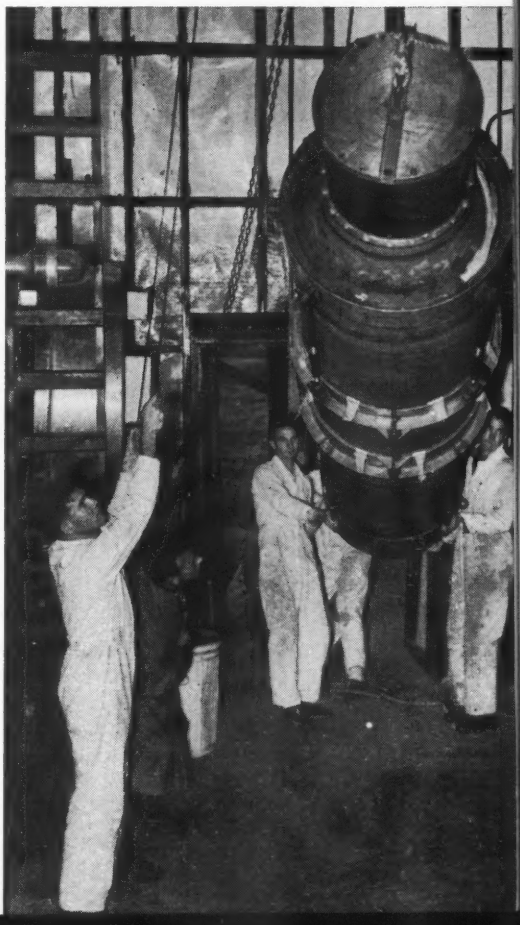
The new safety equipment paid off. Malfunctioning missiles can now be permitted to fly the maximum distance before being cut down within the boundaries of the range. This provides more data on technical troubles arising in flight.

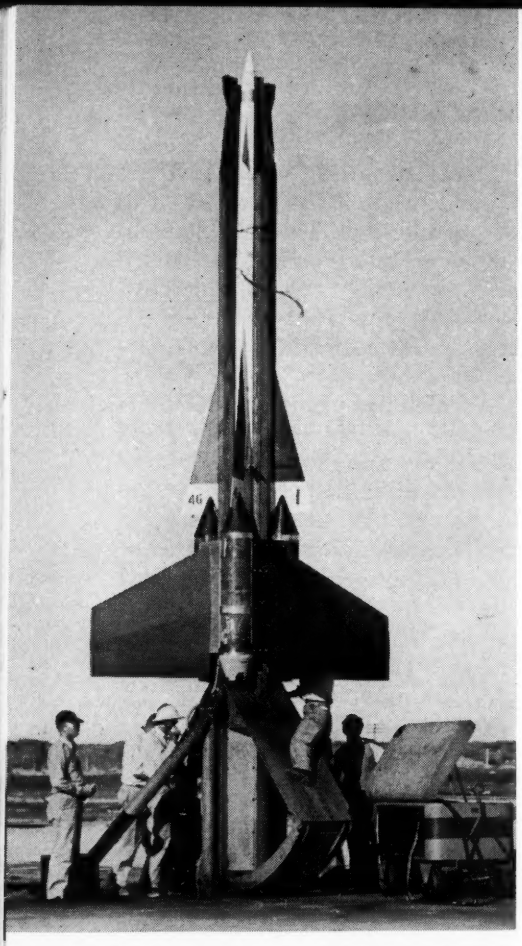
ARMY Ordnance early established a policy of contracting with the most capable civilian scientific and industrial organizations available. Further, the development of an entire weapon system should be, whenever possible, placed with a single firm.

A guided missile system involves a great many items in addition to the missile itself. There are launchers, radars, firing panels, test equipment, servicing vehicles, protective clothing, cold weather kits, drawings, specifications, instruction manuals and so forth.

Normally a prime contractor is selected, one not only willing and able to develop the system, but also capable of initial production. He in turn is free to sub-contract as much as he determines necessary,

Large solid propellant motors such as this have been developed to compete with liquid propellant engines for guided missiles.





Before the present Nike booster was developed, a cluster of four JATO's was used in early stages of experimentation.

but there is one organization that can be held responsible—one firm to praise or blame. For complicated systems of this nature, a large number of sub-contractors are necessarily utilized because no single industry today includes all the fields required to produce a guided missile system.

IN A normal program, the research and development agency gives a new piece of equipment extensive testing and after all "bugs" have been worked out, turns it over to the using service for field tests which usually result in subsequent modification tests. (See "CONARC's Role in Development and Test," April 1956 DIGEST.)

Upon approval, production agencies take over and negotiate contracts. The production items are then turned over to a third group who store and issue the items to troops as needed, and provide for necessary maintenance service. Finally, special schools train the technical personnel who will service the equipment.

But in the case of missiles, a stepped-up procedure was followed. Once the new systems looked promising on the proving ground, there was great demand to get them into early production, and for good reasons. In the surface-to-surface category, need for new day-and-night, all-weather weapons was clearly established during the Battle of the Bulge in Europe, the action at the Yalu River in Korea, and other engagements. In the antiaircraft field, more effective weapons were also required because jet aircraft were already outstripping our best antiaircraft artillery.

As a result, the most urgently required missile systems were "crashed"—that is, the steps which were normally done in series were now telescoped, or carried out concurrently as quickly as possible. This of course generated new and additional problems, but the challenge was accepted and resolved by our Ordnance-Science-Industry team. As a result, the new weapons are now in operation considerably ahead of the original schedules.

IN THE post-World War II era,

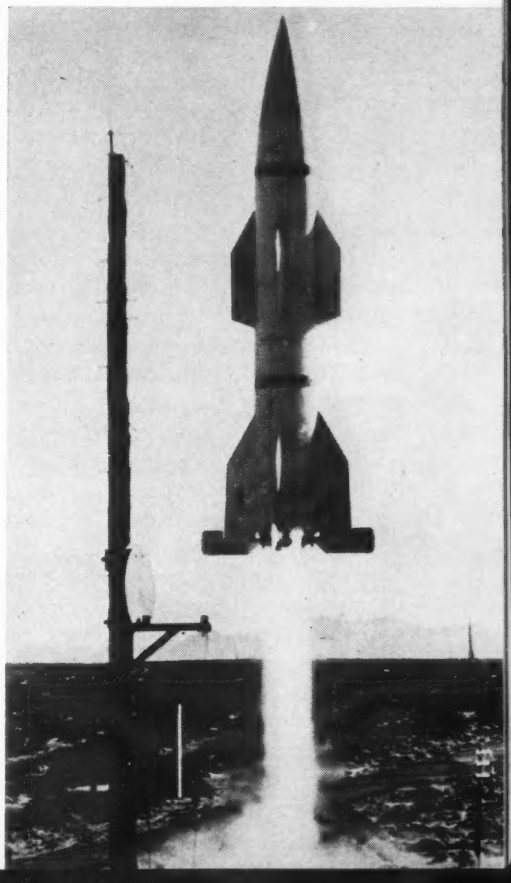
as it became evident that guided missiles would become essential weapons of the future, each of the armed services showed increased interest in the missile business. Army Ordnance had pointed the way through dynamic investigations and initiation of programs in the field. It was natural, then, that there developed questions about the control of these new and sensational weapons.

The Army ground forces were primarily interested in the type of guided missiles that Army Ordnance was best qualified to produce—namely, the supersonic rocket and ballistic types. Logically these were an extension of artillery. But the dual nature of these new weapons served as a basis for the Army Air Force's (AAF) view that guided missiles supplemented aircraft and therefore should come within their field of responsibility.

A series of opinions and directives supported the Army ground force views. The first delineation of Ordnance and AAF responsibilities was made by the New Developments Division of the General Staff in September 1944. By this decision the Ordnance Corps was assigned the wingless ballistic type missiles and the AAF the winged pilotless aircraft types. These responsibilities were formalized the following month by a directive assigning to the Army Service Forces research and development of guided or homing missiles launched from the ground and which depend for sustenance primarily on momentum, and to the AAF those missiles depending primarily on the lift of aerodynamic forces.

In 1946 the subject was reopened on the question of whether the Army missiles under development were supersonic pilotless aircraft not sustained in flight primarily by momentum of the missile. The Guided Missile Committee of the Joint Committee on New Weapons —then engaged in coordinating the various service projects—surveyed the situation. In its "Dewey Report," the Committee stated that research and development in the field of guided missiles must inevitably involve some competition, and that a certain amount of duplication was valuable. The report

A Hermes A-1 takes off on a flight test made in May 1953 at White Sands Proving Ground.



suggested that a system of mutual agreement would be better than setting inflexible boundaries.

MANY studies and proposals for an integrated program were then made, culminating in a War Department decision in October 1946 that within the Army the AAF be given overall cognizance for all guided missile development, but stipulating that Ordnance Corps projects were to continue under the sponsorship of the agencies doing the work. Shortly thereafter the AAF was given equal status with the Army and Navy, and relinquished its responsibility for the Army program.

Army then assigned primary cognizance of its development program to the Ordnance Corps and requested that skills in all development agencies within the Army be utilized to effect maximum contribution to the national guided missile program. Consideration was given to whether the Signal Corps should maintain cognizance over the electronic portions of missile systems, but it was decided that the close inter-relationship between the various elements of a missile system preclude a division of responsibilities. This settled, the Signal Corps, as well as the Corps of Engineers and Chemical Corps, continued to render valuable technical assistance to the Ordnance Corps.

Coordination of Army, Navy and Air Force programs, started by the Dewey Committee, was taken over by the Joint Research and Development Board, and continued by its successor, the Research and Development Board (RDB). By 1948 the question of jurisdiction still had not been settled to everyone's satisfaction. RDB proposed that projects be assigned on an individual basis with consideration of such factors as intended use, technical competence, and availability of manpower and facilities.

In 1949 Secretary of the Army Gordon Gray recommended simply that each service develop the missiles it would use operationally—*i.e.*, ground-launched to Army, ship-launched to Navy, and air-launched to the Air Force. Shortly thereafter General Omar Bradley, Chairman of the Joint Chiefs of Staff, laid down the policy that guided missiles would be employed by each armed service in a manner and to the extent required to accomplish its assigned missions. He wisely made no decision on the dividing line between short and long-range missiles.

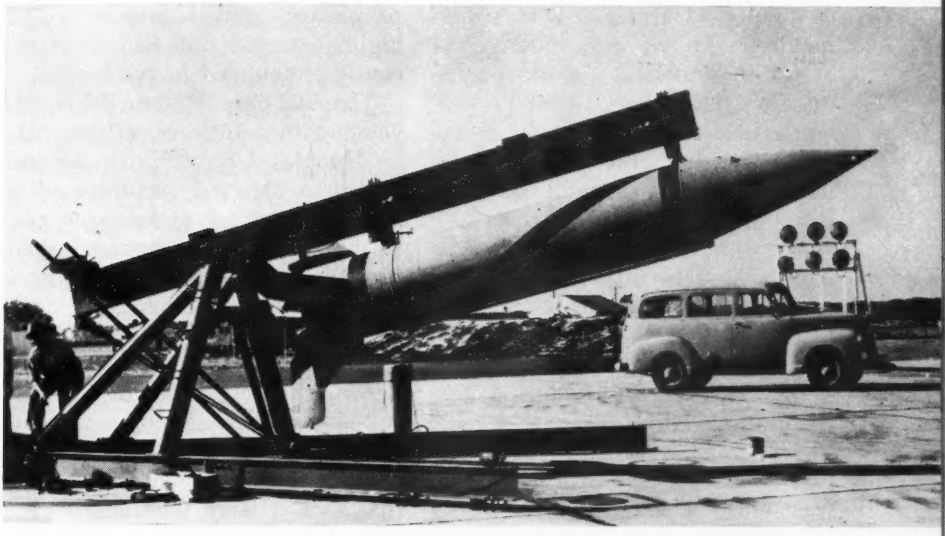
For technical reasons assignment of fixed range limitations would have been unwise. A missile of 100-mile range, for example, can be modified for effective use at much greater ranges by extending its length to accommodate more propellant and by substituting a lighter warhead. More important, however, is the fact that experience gained by a development team in producing a reliable missile system, and their application of proved principles and components to a new longer-range missile of similar type, insures a much better chance of success and at a great saving of time and money.

NO history of the United States' guided missile effort would be complete without mention of the part K. T. Keller played between 1950 and 1953 in his role as Director of Guided Missiles for the Secretary

of Defenses. The Secretary of Defense, then Mr. Louis Johnson, had established the Special Interdepartmental Guided Missiles Board, to study whether unnecessary duplication in projects existed and to make recommendations. Mr. Keller was given the task of monitoring the program.

After careful study, he selected the most promising Army, Navy and Air Force systems for production long before development had been completed, realizing that far greater quantities of missiles would be required for engineering tests, and that industry, too, would require several years to develop a uniformly satisfactory production of these complex items. Mr. Keller's leadership in accelerating the most promising projects resulted in the availability of operational guided missiles far sooner than normal procedures would have permitted.

FROM 1944 on, the Army program progressed amazingly well, considering that through fiscal year 1950 Ordnance had available only 17 percent of the total funds expended on the Army, Navy, and Air Force guided missile effort. Nevertheless the ORD-CIT project at JPL and the Hermes project at General Electric established a great amount of fundamental technical information on missile design.



First of the large solid propellant motors was tested by this Hermes RV-A-10 test rocket shown on an erector-launcher rail.

The Corporal followed the WAC Corporal and Private series, as research test vehicles. General Electric was firing its Hermes A-1 interim surface-to-surface missile, moving along with its Hermes A-2, and working hard on the longer-range, high-performance and extremely accurate Hermes A-3. Lacrosse, initiated at Cornell Aeronautical Laboratories by the Navy for Marine Corps use against strong points, was transferred to the

Army by Joint Chiefs of Staff action and progressed out of its study phase into experimental design.

As time went on, reorientation of this missile program became necessary for several reasons—new atomic warheads were developed; funds available to the Army were limited; and the unsettled international situation intensified the urgency of obtaining operational missiles. Project Hermes was affected the most. The Hermes A-1 was cancelled as a weapon; Hermes A-2 was suspended with view to redesign as a solid propellant "work horse" missile after a large solid propellant rocket motor had been developed; this left only the A-3 as a major effort at General Electric. Responsibility for the Hermes C-1 study was transferred to Redstone Arsenal and became the Redstone project (designated in the interim as Major).

DURING the Korean action the requirement for a surface-to-surface missile became so urgent that the Corporal research vehicle was "crashed" as an interim weapon system on the premise that it could be made operational considerably sooner than the more refined Hermes.

By 1951 it was determined that the Army's surface-to-surface requirements would be met by a family of guided missiles consisting of Corporal, Hermes A-3, and a proposed Redstone. These were to be the carriers of three different sizes of warheads; but again atomic warhead developments overtook the missiles; and later when two warheads satisfied the Army requirements and funds became extremely short, the Hermes program was regretfully terminated.

POSTWAR developments of new and greatly improved solid propellants for rocket engines at JPL and Redstone Arsenal gradually placed them in a competitive position with liquid propellants for guided missile use, both as to performance and to size. First flight tests of a large solid-propellant motor were made in the Hermes RV-A-10 test vehicle. Another solid propellant guided missile is the highly accurate anti-tank Dart, recently announced in production.

The 762-mm. Honest John, developed in a little over two years by Douglas Aircraft Company and Redstone Arsenal, represented a new concept in rocket weapons. It was simply an unguided solid propellant rocket, aimed and fired from its mobile launcher like artillery, and capable of carrying both atomic and conventional warheads. Before the test firing of the first 762-mm. rocket, serious consideration was being given to cancellation of the project on the grounds that such a large unguided rocket could not possibly have the accuracy to justify further expenditure of funds. At this time a Texan was overheard making statements hard to believe. When his veracity was questioned, he exclaimed, "Why around these parts I'm called 'Honest John!'" Feeling somewhat like the Texan at the time, the writer felt Honest John would be an appropriate nickname.

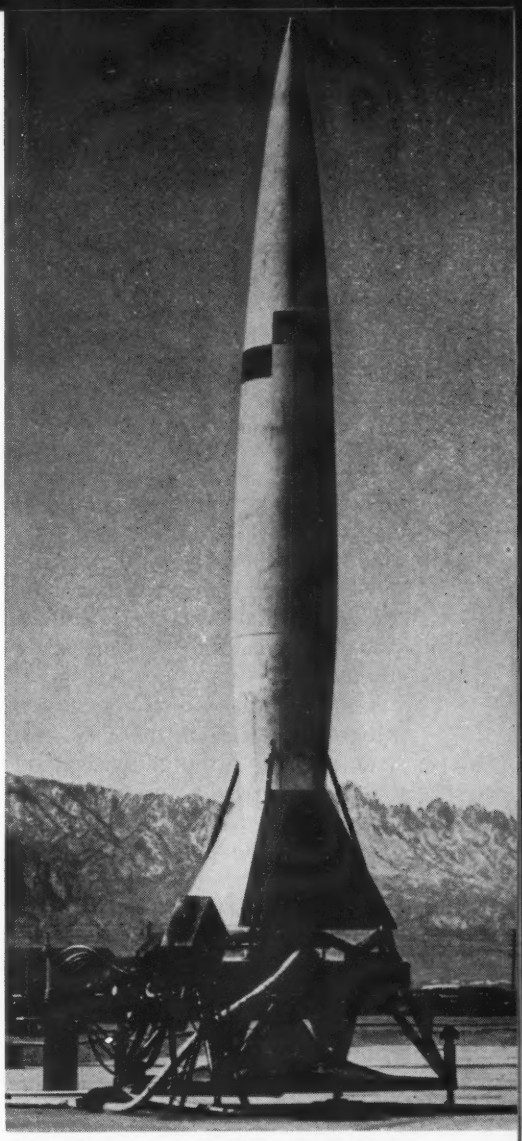
IN THE antiaircraft field Nike took form, and from the beginning looked so promising that another contractor, General Electric Company, was relieved of any surface-

to-air responsibility. Although Army Ordnance never lost confidence in the successful conclusion of Nike I, Navy time scales indicated their Terrier would be operational some time before Nike. Accordingly Army decided to use Terrier as an interim weapon, and Ordnance was directed to develop a suitable ground control system for this ship-launched missile. Before the ground system had been completed, Navy schedules had slipped to the point where Nike would become available for operational use first, and therefore Army's Terrier ground equipment was transferred to the Marine Corps.

Advances in the art, particularly in the field of electronics, resulted in the present Army family of surface-to-air projects consisting of the Nike and other missile systems.

BY 1949 the Army Ordnance program had grown to the point that it was necessary to decentralize the management of the research and development, procurement, and field service activities from the Pentagon to a field installation. Accordingly two adjacent wartime ammunition manufacturing installations near Huntsville, Alabama, were reactivated as Redstone Arsenal and designated as the permanent Ordnance Corps commodity arsenal for rockets and missiles.

In addition to planning, directing, and supervising Ordnance missile activities nationwide, the Arsenal is charged with operating facilities for research and development work in solid propellants, free flight rockets, and guided missiles. Two highly competent contractors, the Rohm and Haas Company and the Thiokol Chemical Corporation, agreed to operate the Arsenal's solid propellant laboratories. Experienced Ordnance rocket personnel were moved in from other installations to staff the Rocket Development Laboratory and testing facilities. The German team was transferred to the Arsenal and became the nucleus of the Guided Missile Development Division of the Ordnance Missile Laboratories. The Ordnance Guided Missile School was also established at



The Hermes A-3, above, was developed in 1953.

Redstone to train civilian and military personnel in the handling and maintenance of these new weapons. Both individual and unit training is conducted to provide proper Ordnance support for the using troops.

Thus Redstone Arsenal has built up highly qualified and experienced teams which can carry a rocket or guided missile project through from preliminary design, component development, fabrication, and final test in specialized and integrated facilities; then manage the procurement and storage, issue, and maintenance of these weapon systems as well as conduct the necessary training.

The Ordnance Corps' foresight in integrating the former German scientists into its organization has given the Army a unique guided missile team having the most advanced development and operational experience in the world.

The Arsenal's Guided Missile Development Division, under the direction of Dr. Wernher von Braun, gained national recognition for its competence in developing the Redstone missile. In February 1956 the personnel and facilities of this division became the backbone of the new Army Ballistic Missile Agency, established for the expedited prosecution of a program to place the Intermediate Range Ballistic Missile—the Jupiter—and the shorter range Redstone missile in operational status as rapidly as possible.

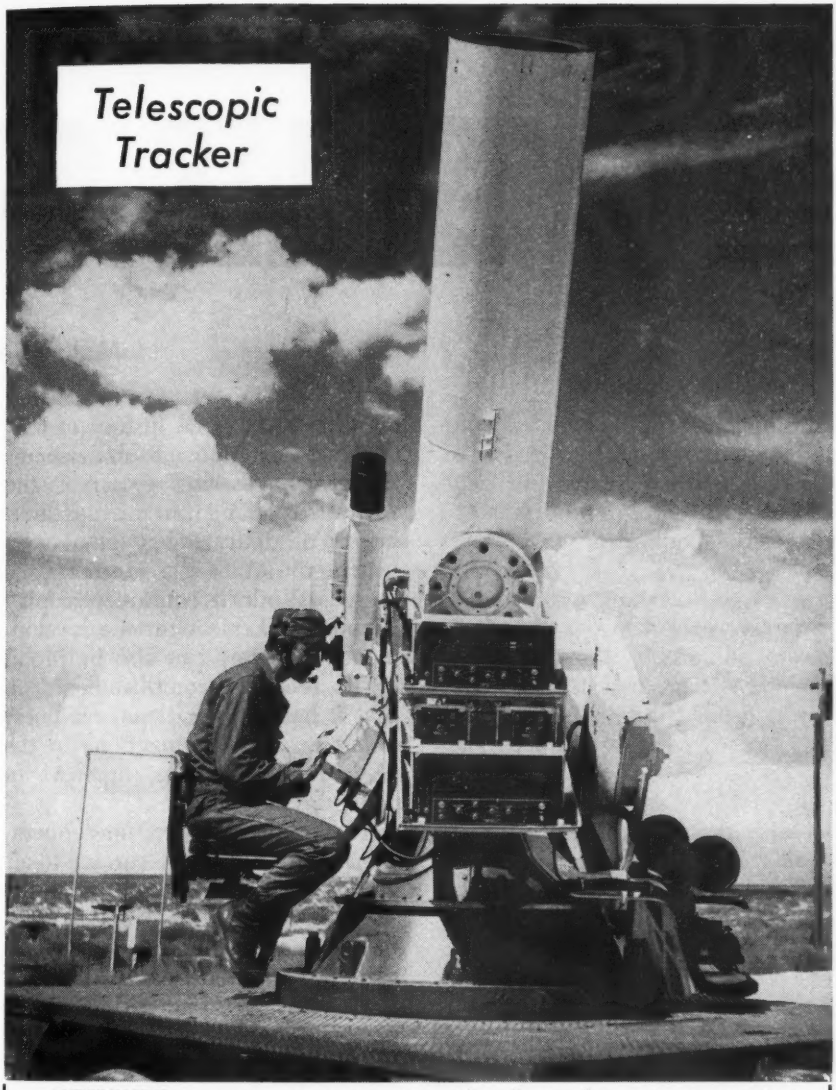
THROUGH the years, in spite of jurisdictional problems and limited funds, the Army program has maintained a position of technical leadership in its fields of interest and has contributed much to the national program.

At the working levels of all three services, excellent liaison is maintained among the various projects. Cooperation and a full free exchange of technical information is the rule rather than the exception. Army-developed rocket motors, for example, are used on the Air Force's air-to-air missile, Falcon; the Army in turn has utilized an Air Force power plant for its Redstone missile. A Navy solid propellant was used in the Honest John rocket. Many more instances could be cited.

Among its many contributions to the national effort, the Army performed pioneering work in establishing the feasibility of an earth satellite program. Extensive studies by Ordnance personnel at Redstone Arsenal helped pave the way for the current U.S. satellite project established under Navy cognizance.

America can be proud of the technical achievements of the Ordnance-Science-Industry team which pioneered in the art of rocketry and produced this country's first supersonic guided missile weapons in a relatively short period of time. An equally progressive development effort is continuing on a family of new guided missiles which will better meet the varied requirements of our modern Army.

And while science continues to forge ahead, this is no time to rest on our laurels. The present state of the guided missile art indicates that any place on the surface of the earth may be reached with a reasonable degree of reliability and accuracy by these vehicles in the near future. All Army research and development efforts are dedicated to maintaining the peace by furthering U. S. supremacy—and staying ahead of any potential enemy.



DESIGNED to operate in conjunction with radar tracking sets, a new giant telescopic tracker that can trace a missile—balloon, rocket, or artillery shell—300 miles away now is being tested after being developed at the Army Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey.

Employing a "crystal ball"—a steel sphere rotated in a socket to move the instrument—it will follow a target as directed by a radar set; or conversely a radar may follow a target as directed. Weighing a ton and a half, the optical colossus has a 400-pound lens of 160 inch focal length which shows aerial objects in natural color.

Among uses of the tracker are tracking and photographing of high altitude meteorological balloons, locating position in space of rockets and artillery shells, and the evaluating of radar systems. It may be remotely controlled so it can be placed in danger areas to record impact of rockets or other missiles.

Neither projected nor in the planning stage, but actually operational today are these

MISSILES ON T

Major General Earle

THE POSTWAR history of missile development underscores the ever-increasing emphasis the Army is placing on missiles as a means of delivering a lethal warhead against either an air or surface target. While it continues to play its important role in missile development, the Army can also be proud of its recent accomplishments, in that it has in operational readiness *today* missile organizations in the field ready to fire against an aggressor.

Three missiles are now operational—the Nike I, a surface-to-air guided missile; the Corporal, a surface-to-surface guided missile; and the Honest John, a surface-to-surface unguided missile. Each of these missile systems is designed to perform a specific job.

The Nike I is already the backbone of the Army's continental antiaircraft defense. Historically, it was conceived more than eleven years ago when it was foreseen that the airplane would continue to develop a greater speed, a thicker skin and the ability to fly higher.

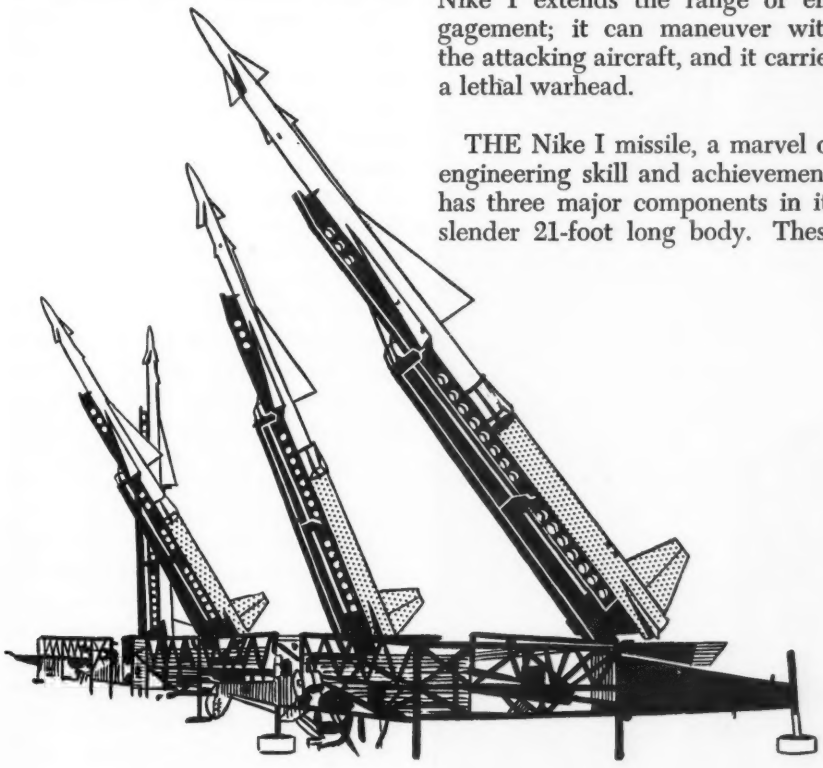
MAJOR GENERAL EARLE G. WHEELER is Director of Plans, Office of the Deputy Chief of Staff for Military Operations, Department of the Army.

N THE FIRING LINE

General Earle G. Wheeler

In order to keep abreast of the increasing aircraft performance, it was necessary to develop an antiaircraft system which would deliver a large warhead to a great altitude and range in a short time and under continuous control to intercept. A remote controlled rocket powered missile seemed to offer great promise in meeting these requirements. The Nike I became the first of a family of new antiaircraft missiles developed in accordance with this philosophy.

In addition to extending the altitude coverage of antiaircraft guns, Nike I extends the range of engagement; it can maneuver with the attacking aircraft, and it carries a lethal warhead.

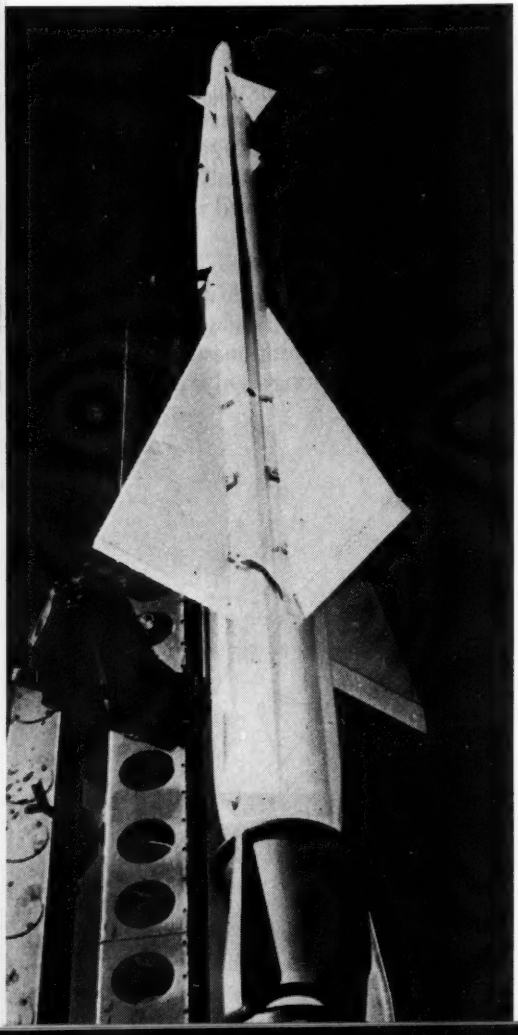


THE Nike I missile, a marvel of engineering skill and achievement, has three major components in its slender 21-foot long body. These

are the rocket motor to provide propulsion; a guidance package to steer it to the target; and a lethal warhead to destroy the target at the intercept point. These three major components will be found in any guided missile. In addition there is, of course, a launcher or mount from which the missile is fired.

Actually, Nike I has two motors, one of which is a solid propellant booster to drive the missile off its launcher with a tremendous acceleration. A few seconds later, after it has expended its fuel, the booster separates from the missile. The missile's self-contained liquid fuel sustainer rocket motor then takes over and provides enough propulsive force to maintain Nike I's supersonic speed all the way to the point of target interception.

AT THE READY. *A Nike missile points skyward on its launcher ready to . . .*



PART of the Nike I guidance system is contained aboard the missile but most is with the Nike battery ground control set. Located with the battery ground set are two radars, one of which tracks the target and sends target position information to a computer, while the other tracks and sends guidance commands to the missile.

The computer does the actual "thinking." It must continuously determine where the missile will intercept the target based on its present course, then send commands which maneuver the missile to this intercept point. If the target takes evasive action, the computer must determine a new point of intercept. Actually, the device continuously computes the predicted point of intercept. The guidance system, aboard the Nike I missile, receives and interprets the commands and transmits them to the fins which cause the missile to maneuver to the intercept point. Since there is no human aboard the missile, its capability for tight maneuver is not restricted on this account.

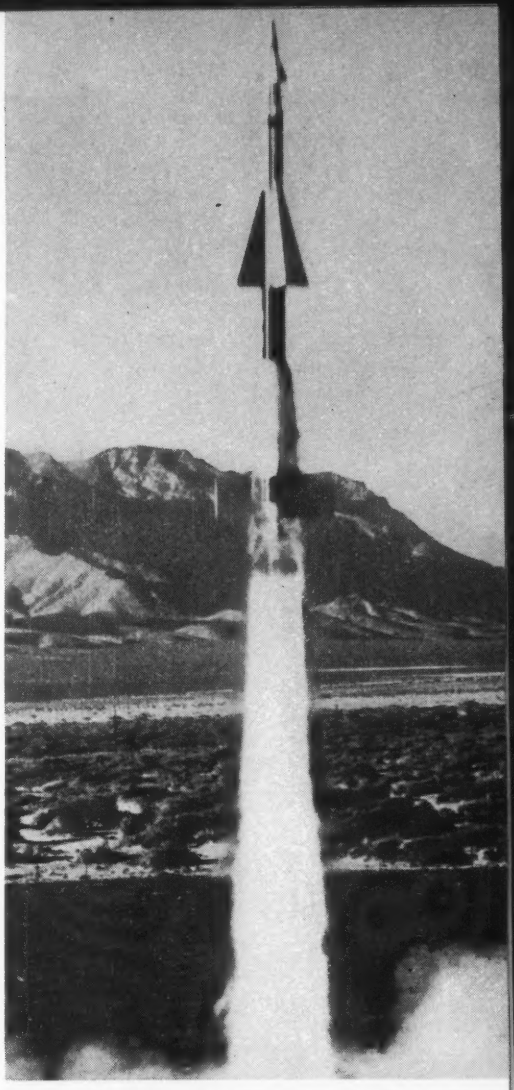
The third major component of the Nike I missile is its warhead. This warhead causes a large-radius, spherical burst pattern upon detonation. The combination of missile

accuracy and the lethality of its warhead gives the Nike I a high kill probability. This, coupled with the missile's relatively long range, permits a Nike I antiaircraft defense to exact a high kill rate against attacking aircraft.

NIKE I is the basic weapon of a battalion which has four firing batteries. Each firing battery has a set of ground control equipment and three launcher sections, each with four launchers. Each firing battery is a complete fire unit.

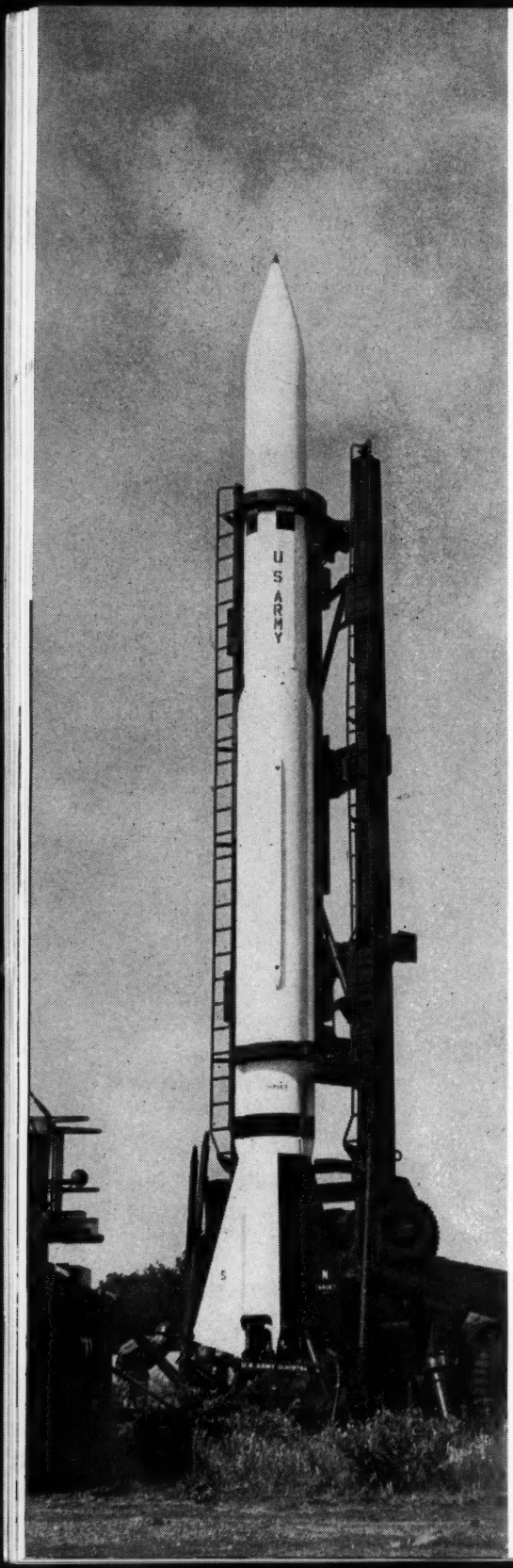
During a fire mission the missile on the elevator-launcher of one launching section is fired, followed by the missile on the elevator-launcher of the second launching section, with the third missile then being fired from the elevator-launcher of the third section. Using this sequence each section can reload the elevator-launcher while the other two sections are firing, and consequently maintain the maximum rate of fire. This procedure is followed as long as missiles are available in the underground storage area. When these have been exhausted, the three missiles located on satellite launchers at each section are fired as desired by the unit commander.

In the past few years, the Army's Nike I has received considerable publicity for a variety of reasons: First, Nike I battalions are deployed around critical installations, cities and facilities in the United States, and soon some Nike I battalions will be deployed overseas; second, Nike I's effectiveness represents a "breakthrough" of the limitations imposed by gun type, predicted-fire air defense weapons. In the foreseeable future, surface-to-air guided missiles will no doubt totally replace gun type antiaircraft weapons.



TAKE OFF. *Roaring upward the missile starts for a lethal rendezvous with enemy aircraft.*

JUST AS the requirement to improve antiaircraft weapons was foreseen and translated into Nike development, so too was the requirement for ballistic missiles as an extension of field artillery. This resulted in the development of the



guided Corporal and the unguided Honest John.

Modern conventional field artillery cannon still perform a vital fire support role for ground forces. However, the maximum range of the mobile, general purpose cannon is about 35,000 to 40,000 yards. Cannon with longer ranges have been built but, because of their size and weight, they do not have sufficient mobility to allow their use in a mobile combat situation. The Germans realized these limitations and countered them by development and employment of the V-1 and V-2 during World War II. Both of these missiles considerably outranged the cannon.

Increased range is one of the most obvious requirements for the development of ground support missiles. However, at least two other capabilities of missiles should be considered. One is their ability to carry efficient, highly lethal atomic warheads; and the other is the relatively light weight and resultant mobility of the launching platform, compared to cannon.

THE Corporal guided missile was developed to provide the Army with an atomic delivery system which could both extend the range of field artillery and provide ground forces with a readily available means of all-weather, heavy fire support.

Like Nike, Corporal has propulsion, guidance and warhead components. However, Corporal has no booster motor to bring it rapidly

PREPARED TO FIRE. *A Corporal missile being made ready to carry against ground targets its load of . . .*

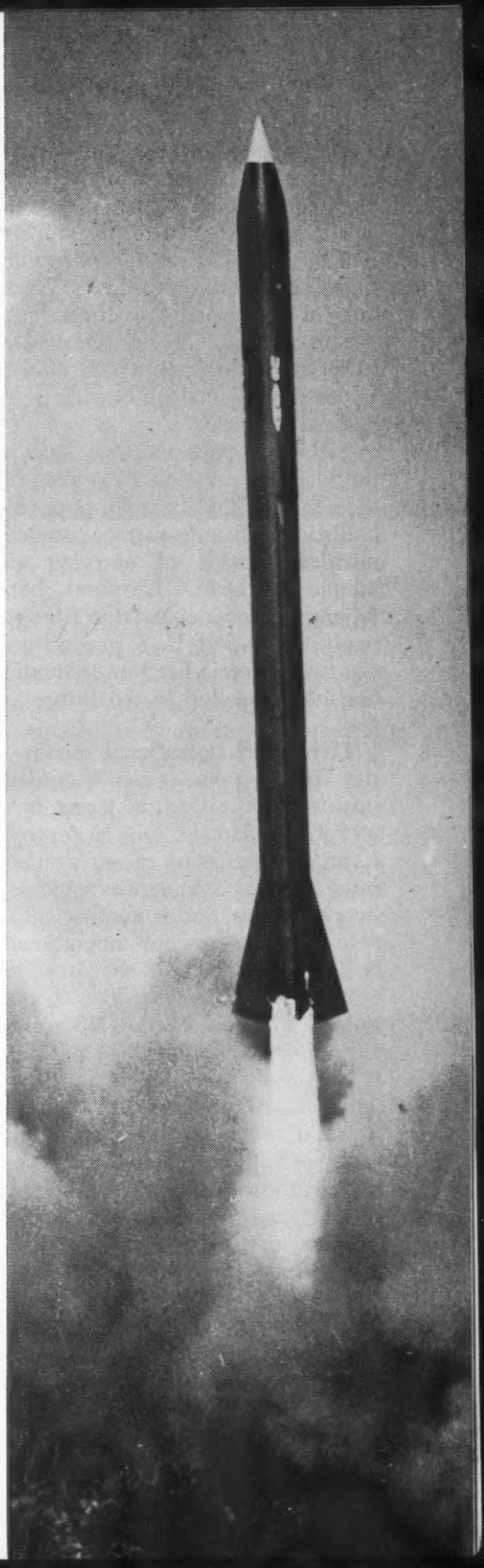
to speed; rather, it has an internally mounted liquid propellant rocket motor which slowly lifts the missile off its launcher, and which propels the missile to a velocity many times the speed of sound and to a range far beyond that of conventional artillery. This is sufficient range to provide heavy fire support for an entire Corps against targets deep in enemy territory.

The Corporal motor burns only during the initial portion of its trajectory. After the fuel has been shut off (at a position and velocity required to hit a particular target) Corporal follows a ballistic trajectory. Thus the Corporal is supported in flight entirely by its momentum, similar to an artillery shell fired from a cannon.

Like Nike, Corporal guidance is located in the missile and at the ground control station. A radar, a computer, and a doppler radio are used on the ground to control and communicate with the missile.

The computer is the source of guidance commands which are sent to the missile by the radar. In determining the proper commands, the computer depends on missile position data from the radar and missile velocity information from the doppler radio, as well as the data pre-set into the computer before firing.

Pre-launch firing data are set into the computer. During flight, the computer functions as the brain of the guidance system. It receives information from both radars and, from this, determines guidance commands to be sent to the missile.



SWIFT DESTRUCTION. *With a fiery roar it blasts off to destroy enemy positions.*

The missile-borne guidance performs certain functions independent of the ground control set. It stabilizes the missile vertically during take-off and, at the appropriate time, causes the missile to pitch over in the direction of the target.

Corporal can carry any one of a variety of warheads which allows for selection of the most efficient amount of destructive power required for a particular mission. It is the first operational member of the family of rocket powered ballistic surface-to-surface guided missiles capable of carrying an atomic warhead. Corporal battalions are now deployed in Europe ready to support U. S. ground action with atomic fire power should hostilities develop in the future.

THE third operational missile—the Honest John—is not a guided missile, but rather a large free rocket. The Honest John at present forms the backbone of our ground force tactical atomic weapons delivery systems, and is another valuable member of our operational family of fire support weapons.

Why is the Honest John not a guided missile like the Nike and Corporal? Actually, its evolution is unique in that Honest John began life as a jet assist take off unit. A solid propellant rocket motor booster, with an even thrust, was needed to accelerate the launching of certain guided missiles. The booster motor developed for this purpose had such good thrust features that it sparked the idea for a new weapon. Why not attach fins and a warhead on this motor and fire it as a large rocket? Needless to say, the idea worked.

Subsequent improvements in the rocket, coupled with the development of effective gunnery techniques, has made Honest John a reliable atomic artillery delivery vehicle for support of ground operations. To provide system mobility, a mobile launcher is employed.

Honest John is not a guided missile because it has no guidance component included in its system.

In aiming at a particular target, standard firing tables provide data which are modified by the application of meteorological effects. Prior to firing, the firing data are applied to the missile launcher by laying it for both direction and elevation. When fired, the Honest John follows a ballistic trajectory to the target. These firing procedures are identical to those used for firing conventional artillery weapons.

The 27-foot, three-ton Honest John is fired from a launcher which is relatively much lighter and more mobile than a long-range gun. This self-propelled launcher can transport a rocket on its rail during movement, and can go into a position and fire in a matter of minutes. The launcher can then move out of this position immediately after the missile has been fired.

The atomic threat that Honest John presents to a hostile force is so great that such units are certain to be prime enemy targets. Therefore the ability to go into a position, fire, and move out, is a matter of vital importance, since the Honest John will be firing from forward positions where it is more prone to detection by the enemy as compared with the long range missiles emplaced well to the rear.

The rugged simplicity of the Honest John system, and the atomic warhead it can deliver,

A rocket rather than a guided missile, the Honest John greatly extends the striking power of the artillery arm.

make it an important member of our present family of atomic fire support weapons. Its supersonic, free flight characteristics make it immune to any known countermeasures once it has been fired. The ability to load both rocket and launcher in cargo aircraft makes it a potential defense against hostile action at any point in the world.

The Army has requirements for missiles to perform a variety of tasks. Undoubtedly new missiles will soon take their place alongside Nike I, Corporal, and Honest John. Indeed, several significantly successful ones are in an advanced state of development. But in the fields of antiaircraft defense and ground atomic fire support these three missiles—operational, effective, and deployed for instant action *today*—are justifiably a source of pride to the Army and Nation.

INTRODUCING LITTLE JOHN. *Now being built at Redstone Arsenal is the 318-mm. Little John XM47, a small caliber, 12-foot-long field artillery free rocket.*

Army funds, facilities and scientific talent are concentrated on the priority task of

MISSILE RESEARCH AND DEVELOPMENT

Major General J. P. Daley

"The Chief of Research and Development, Department of the Army, has the mission of research and development on a priority basis to attain increased Army missile capabilities."
AR 525-30, Army Missiles, dated 28 August 1956.

TOMORROW'S weapons are today's business in Army Research and Development, and an extremely important part of that business is the development of missiles for the more mobile, more powerful Army of the future.

Just how important this task is regarded, is indicated by the fact that of the $380 million expended annually on Army research and development, approximately one-third is devoted exclusively to the Army missile program.

¶ Why is such priority being given to missile development?

¶ What are the objectives of the program?

¶ What resources are being applied to fulfill this priority task?

These are some of the questions which logically occur. Let us examine each in detail.

MAJOR GENERAL J. P. DALEY is Director, Special Weapons, Office of the Chief of Research and Development, Department of the Army.

WHY MISSILES?

The Army of the future, it is generally recognized, will operate in a battle area both wide and deep. This creates a requirement for weapons of greater range and mobility, capable of delivering a diversity of firepower. Furthermore, this army must be capable of providing for itself a high level of air defense.

Rapid technical progress in the missile and atomic fields—both of which rose to prominence only recently, in the closing days of World War II—today furnish the basis for meeting the Army's new requirements. The missile and the nuclear warhead give us the means to provide the firepower of the future. This is why the Army gives priority to the development of missiles.

This is why one-third of the Army's Research and Development budget is spent in the missile field.

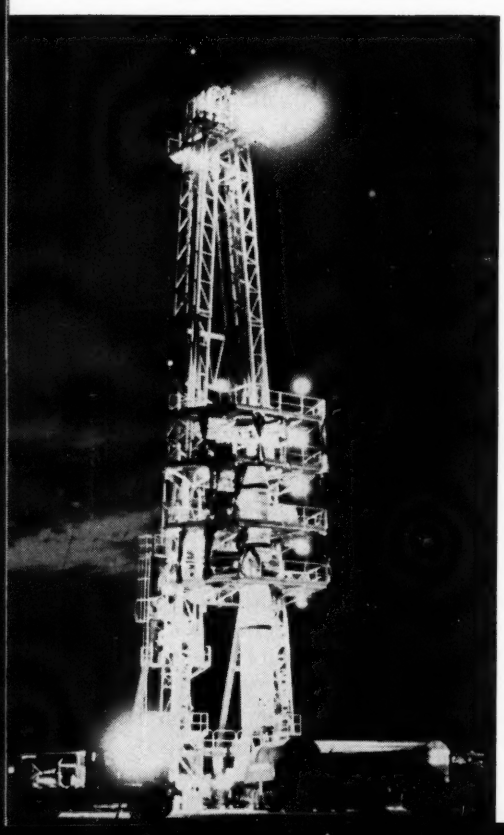
OBJECTIVES

THE ARMY'S program to provide needed firepower for the future is concentrated in two separate fields of endeavor—surface-to-air, and surface-to-surface. Although in some cases a single missile may have capabilities in both fields, initial development efforts have largely been aimed at providing either a surface-to-air or a surface-to-surface capability.

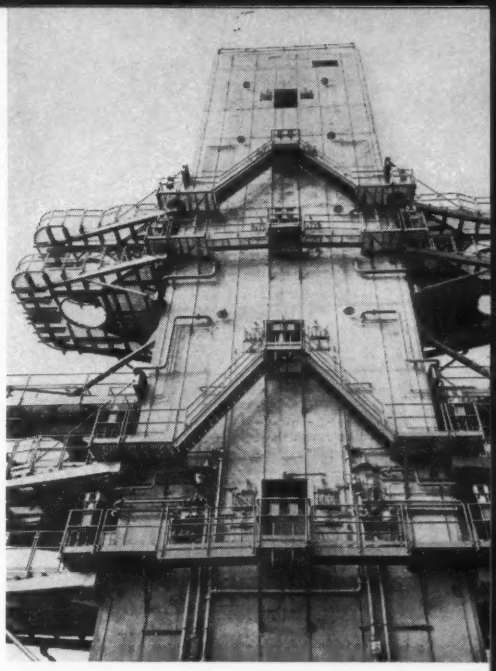
In the *surface-to-air* field, the Army must provide weapons for air defense of the field army and of overseas installations, and also weapons for antiair units deployed in defense of the Continental United States. Accordingly, initial efforts have been concentrated in the development of a surface-to-air missile system which could be used in the field army and which could then be adapted for use in fixed defense. The present Nike I system, now deployed around many of our industrial centers, was developed in consonance with this concept.

This dual-use concept is being re-examined in relation to our future programs. While in most cases we still expect that the basic surface-to-air systems may have dual application, in all probability there will be two versions—one modified to take maximum advantage of the automation possible in a fixed installation, the other version adapted to mobile field use in a battle area.

Varied and complex are the many facets of research and development in the missile field, ranging from utilization of basic sciences to complex industrial efforts, such as designing huge new structures to be used in testing latest developments in the missiles



Today, as part of its comprehensive surface-to-air missile program, the Army is developing systems to make defended areas unsafe for any enemy aircraft, high-flying or low-flying. A concerted development program is being directed to meet the threat of cruise type surface-to-surface missiles, air-to-surface missiles, and ballistic missiles. The objective—an attainable one—is to make the man on the ground the master of the air above him.



themselves. Lower left, the Redstone missile is fueled and checked from this unique servicing structure that will roll away if anything goes wrong. Upper right, a dramatic view of the 140-foot static firing test stand for rocket motors.

In the *surface-to-surface* field, the Army missile development program seeks to provide the Army commander with all the types of weapons he requires for success in ground combat. These include antitank missiles, short-range assault missiles of great accuracy, missiles to extend the artillery's all-weather day or night firepower, missiles needed to support the highly mobile, fast-moving, widely separated combat units of the future.

The missiles themselves are designed as carriers of varying warheads, from small, special-purpose, high-explosive types through nuclear ones with a variety of yields. These surface-to-surface missiles must provide the ground commander with all-weather, around-the-clock fire support completely responsive to his needs.

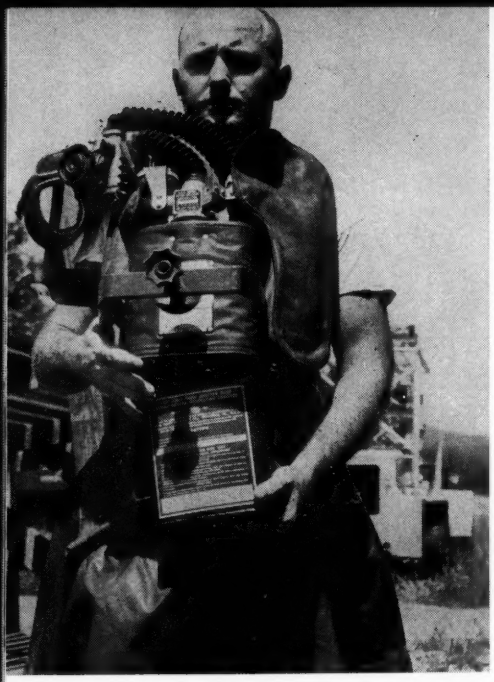
And while such surface-to-surface missiles as the Honest John rocket and the Corporal guided missile are operational—*i.e.*, in the hands of our troops today—actually they are but the beginning. Improved versions are already in the development stage. We are developing a lighter rocket than Honest John, known as Little John, far more mobile, far more adaptable to air movement. Another new weapon, the Lacrosse, will provide an air-transportable weapon of high accuracy capable of assuming the destruction missions formerly performed by heavy artillery.

The Redstone and Jupiter guided missiles are under development in the longer-range ballistic missile field.

The Army is justly proud of its progress in development of surface-to-surface guided missiles and rockets—proud, but not satisfied. Increased ranges for our smaller missiles, higher accuracy, more reliability and lighter weight are some of the major improvements being sought in the weapons which will follow Little John and Redstone. Always, the paramount objective of the Army's surface-to-surface missile development program is to provide the ground commander with reliable, flexible, powerful fire support, available at the right time, at the right place, and in the right amount.

FACILITIES AND RESOURCES

WHAT channels, facilities and



Oxygen-breathing apparatus is used by missilemen handling highly toxic nitric acid that propels the Corporal missile.

resources are available to the Army to assure success of its missile research and development program?

Normally, a missile development program originates in a suggestion by an individual, military or civilian, that an Army requirement can be met by a missile of certain characteristics. In evaluating such a proposal, the Continental Army Command represents the eventual user, the Chief of Research and Development coordinates the General Staff evaluation, and the Chief of Ordnance comments on the technical feasibility of achieving the desired results.

Once the need and the feasibility are established and necessary funds are available, the Chief of Ordnance is directed to establish a project and initiate development. In the case of missile projects directly related to the Redstone and Jupiter, the Army Ballistic Missile Agency (ABMA) has technical supervision over the projects; in all other cases, technical supervision is exercised by Redstone Arsenal. (See "Army Ballistic Agency," this issue.)

Both agencies are located within the geographic confines of the Army Redstone Arsenal reservation at Huntsville, Alabama. Both direct and coordinate the efforts of a multitude of contractors—industrial firms, educational institutions, and others—that support the Army missile research program.

FOCAL POINT and nerve center of Army missile development effort is the 80-square-mile government reservation known as Redstone Arsenal. This complex includes some 1400 buildings, an airstrip, docks in the Tennessee River, a network of 120 miles of paved road and 100 miles of railroad, and six firing ranges—five for flight and one for static tests. Dominating the scene is a gigantic 14-story tower that serves as a static firing test stand for missiles. Built of reinforced concrete four feet thick, it is connected by tunnel to an observation and control blockhouse a thousand feet away. A giant Gantry crane lifts missiles into position on the tower.

Also at Redstone is a 600-foot ballistic track—one of three in the United States—along which special test sleds can be accelerated to supersonic speeds. Wind tunnels, laboratory buildings, digital and analog computers, machine shops, assembly plants are among the associated facilities which comprise the physical plant.

Staffing the various activities are 6,700 civilian and military person-

nel representing almost every field of science and engineering. Reflecting the caliber of its personnel, some twenty percent of the enlisted men at Redstone Arsenal are college graduates. The entire group lives in a world of guided missiles, and even the nearby town of Huntsville identifies itself as "The Rocket City."

The Army Ballistic Missile Agency located here is organized into three operating divisions—Industrial, Support, and Development Operations Divisions. The latter division, heart of the system, comprises ten separate laboratory groups that cover all aspects of the whole missile and its components. Its scientists, engineers and technicians have achieved world-wide fame as missile experts. They include a talented group of American, German-born specialists headed by Dr. Werner von Braun. This missile group, through Army foresight, was assembled and brought to this country to make up a "team" containing the most advanced developmental and operational experience available.

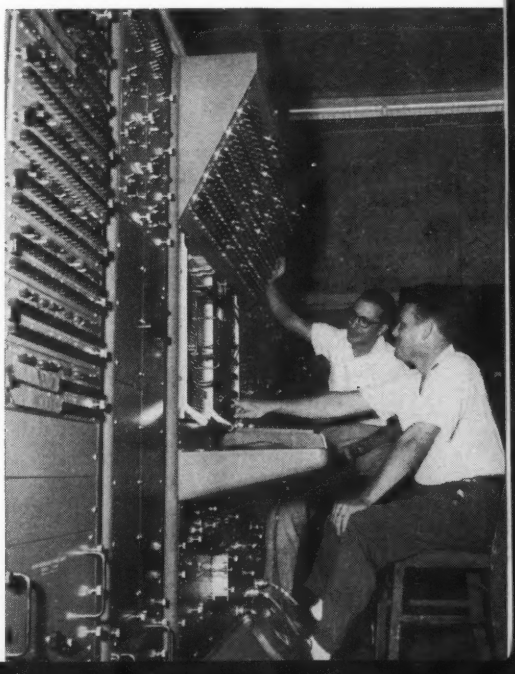
Working in their own laboratories and in close coordination with their counterparts in an extensive contractor structure with private industry, ABMA experts evolve the theories, plans and techniques necessary to produce the Redstone and Jupiter missiles and their components.

The Redstone Arsenal organization at Huntsville comprises a Research and Development Division which plans and supervises work on all types of rockets and missiles other than Redstone and Jupiter. It also initiates work on new and novel designs, with a view to developing prototypes for study and testing purposes.

DEVELOPMENT of a new missile is ordinarily assigned to a single civilian contractor selected by a Contractor's Selection Committee at Redstone Arsenal. Selection is made on the basis of the skilled personnel, laboratory and production facilities available to the firms. Once selected, the prime contractor may sub-contract for various aspects of his work, but he remains responsible for the entire system—airframe, power plant, guidance, launching, and the like.

Throughout the development process there is a constant interchange of information between the contractor and interested Army agencies. When the missile finally

In a few minutes this IBM-type electronic calculator can perform several man-years of work in predicting a missile's performance.



Engineering problems had to be solved in designing this aircraft rocket test firing track at Redstone Arsenal.

reaches the stage where it can be fired, the contractor transfers his activities to the White Sands Proving Ground at Las Cruces, New Mexico—an Army-operated installation under the supervision of the Chief of Ordnance, which services rocket and missile testing requirements of all the armed services.

WHITE SANDS Proving Ground occupies a government reservation 100 miles long and forty miles wide. Seven thousand military and civilian personnel man its ranges and laboratories.

The Proving Ground has four main operational laboratories—Ordnance, Integrated Range, Signal and Ballistic Research—which encompass all phases of rocket and missile flight testing.

Among its facilities are four launching areas, static test stands which can accommodate rocket motor thrusts up to 500,000 pounds, one of the finest meteorological laboratories in the Southwest, and firing ranges instrumented with $30 million worth of equipment. Supporting the test operations is a shock and vibration laboratory with one of the largest shock machines and vibration exciters ever built; an instrumentation laboratory; climatic conditioning and environmental testing chambers; analog and digital computation facilities; a film processing and printing plant and blueprint library. The Proving Ground's extensive communications system includes a chain radar, 130 radio channels and 23 microwave channels, interconnected with 16,500 miles of wire and cable.

MAKING use of these extensive test facilities, the contractor fires missile after missile in the process of establishing the design of the propulsion system, refining the guidance system, and improving missile reliability.

Final step in research and development is the service test by one of the Continental Army Command Boards. (See "Testing Tomorrow's Missiles," September 1956 DIGEST.) These tests are designed to prove that the final product is a combat-

serviceable addition to the Army's arsenal.

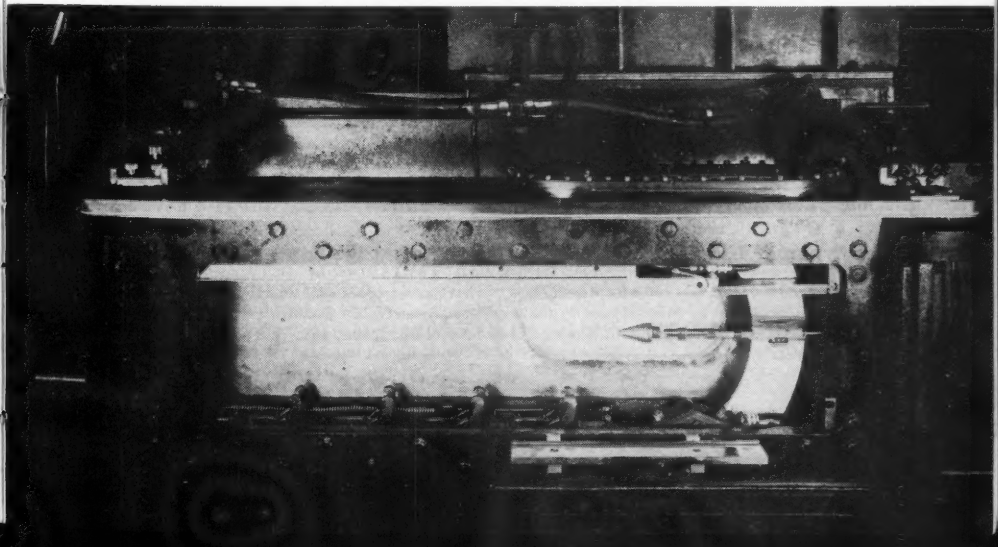
Although it is true that within the Army the Ordnance Corps has the major technical responsibility in development of a missile, it is equally true that in this development the Army relies on the competence of its other technical services—particularly Signal Corps for guidance, electronic countermeasures and range instrumentation at White Sands.

Fortunately, too, although the Army has great resources of its own, the Army's research and development program is a cooperative effort which brings to the Army's assistance the vast capabilities of American industrial and research institutions, including the finest universities, technical schools and research laboratories, as well as large and small industrial firms engaged as prime contractors or subcontractors. The aircraft, automotive, electronics, steel and aluminum industries, to name a few, are all represented in the Army's missile development program. Thus every success is not merely an Army success; it is a tribute to the creativeness and productiveness of American science, management, engineering and skilled labor.

IN ESSENCE, then, the Army's missile development program is a joint product of Army agencies and American industry. The Army's development teams in industry, in our government arsenals, laboratories and proving grounds have the greatest operational and developmental missile experience in the Western World today. They constitute our major resource in the search for better missiles.

In the development of weapons of war, our Nation is just entering the missile age. Today's Army missile program will give the Army of the future the mobile, flexible firepower needed in peace to deter aggression and, if war should come, to assure victory.

A pressure model is tested in a supersonic wind tunnel to determine load distribution on the nose of a Redstone missile.



MISSILES OF OTHER U

U. S. NAVY

(Data summarized in Department of Defense "Fact Sheet on G

PETREL was developed under technical direction of the Bureau of Ordnance by the National Bureau of Standards, primarily for use against enemy ships at sea. Launched by patrol aircraft well outside the range of the target's air defense, the missile attacks at high speed, saving the plane pilot from antiaircraft hazards of World War II. The engineering production phase was coordinated by the Naval Ordnance Experimental Unit, a field activity of the Bureau of Ordnance located at the Bureau of Standards. A number of patrol type aircraft are Petrel equipped.

SPARROW I a supersonic air-to-air missile, was developed by the Bureau of Aeronautics, Naval Air Missile Test Center, Point Mugu, California, and the Sperry Gyroscope Company. Described as a powerful deterrent against attack by jet bombers and fighters, it is about 12 feet long, weighs about 300 pounds, and is powered by a solid propellant rocket motor. Guidance signals deflect the missile's wings and direct it to intercept the target, even under evasive action. The Sparrow I weapons system is versatile, permitting effective attacks against high and low altitude targets flying singly or in groups. The missile is operational in the Fleet and shore-based aircraft.

REGULUS, which resembles a conventional swept-wing jet fighter about 30 feet long, was developed by the Chance Vought Aircraft Company under the sponsorship of the Bureau of Aeronautics. It was designed for launching from submarines, surface ships and shore bases. Launching equipment can be installed in a short period of time on several types of vessels at relatively low cost, with only slight modification to the ship itself. Tactically, it will be used against appropriate land targets and in amphibious warfare by the Marine Corps and the Navy. Although the assault missile and certain other configurations will employ a drone version of Regulus, tactical employment will also include those techniques and guidance systems associated with the operation of all-weather, distantly controlled guided missiles. Such plans will make it possible to utilize the missile in various ways without the expense and effort of designing and procuring a separate missile for each function. The program was started in 1947; the missile was initially developed in 1948, and first flown at Edwards Air Force Base in 1950.

TERRIER was fired experimentally in fleet operations in November 1954 from the Navy's oldest battleship, *USS Mississippi*, which was converted into a test ship for this purpose. The missile was successfully demonstrated in the 1954 Operation LANTFLEX. A slim, needle-nosed supersonic weapon, the Terrier is designed to intercept aircraft at longer range and higher altitudes than conventional antiaircraft guns, and under any weather conditions. Developed by the Bureau of Ordnance under technical direction of the Johns Hopkins University Applied Physics Laboratory, Silver Spring, Maryland, it is being produced in quantity.

TALOS a supersonic guided missile for use in the air defense of the United States, is being developed by the Johns Hopkins University Applied Physics Laboratory, Maryland, under contract to the Navy's Bureau of Ordnance. It will be employed by the Navy aboard ship and by the Continental Air Defense Command. Air Force survey teams will make a study of prospective sites in the continental United States, to be manned by trained Air Force guided missile technicians. Built-in safety features make accidental detonation almost an impossibility. Dimensions of the sites will provide more than adequate safety zones. Rear Admiral John H. Sides, in answer to press queries, said, "Talos . . . larger size than TERRIER . . . and has longer range . . ."

TARTAR On 13 March 1956, aboard the guided missile cruiser *USS Boston*, Rear Admiral John H. Sides, answering direct press queries, said: "TARTAR will be small enough to go into destroyers and the secondary batteries of large ships, yet have more performance than the original TERRIER . . . destroyers are to be designed to carry the missile . . . it can replace five-inch mounts . . . a solid propellant rocket . . . ." Admiral A. A. Burke, Chief of Naval Operations, said, "Tartar should be cheaper than Terrier."

U. S. ARMED FORCES

U. S. AIR FORCE

on Guided Missiles," 25 May 1956.)

MATADOR (TM-61A) a tactical missile of subsonic speed, received its first flight in December 1950 and was operational March 1954. It has a wingspan of 28.7 feet, length of 39.6 feet. Ground launched by a rocket booster from a roadable launcher, it is powered by an Allison jet engine (J–33–A–37), controlled electronically in flight by ground personnel, and is capable of delivering conventional or nuclear weapons several hundred miles. Matador squadrons are already stationed in Germany and Florida. A later version, the TM–61B, is longer and faster and has greater range and improved guidance system. It has been tested in successful launchings at Holloman Air Development Center, New Mexico.

FALCON (GAR-1) is a guided aircraft rocket of supersonic speed. Under development since 1947, it was test fired in 1950. Production was ordered in 1955 and it became operational in March 1956. Falcon, which weighs slightly over 100 pounds and is approximately six feet long, is powered by solid rocket propellant and electronically fired and guided. Designed for under wing or pod installation, it can be carried in quantity by interceptor aircraft, launched miles from target, and automatically "homes" on target. During test period, it knocked down target planes without carrying explosive warhead.

SNARK (SN-62) long-range strategic missile, is undergoing tests at the Air Force Missile Test Center, Patrick AFB, Florida. It is a winged pilotless bomber powered by an Allison turbo-jet engine, and is the first U. S. long-range missile to be test flown. It is considered to have range, accuracy and load carrying capabilities as good as ballistic missile types.

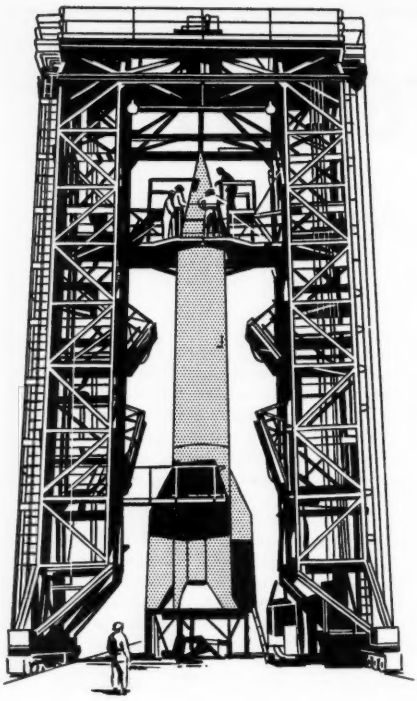
NAVAHO (SM-64) long-range strategic missile, is now undergoing tests at Patrick AFB. Original flight tests were made at Edwards AFB, California. A rocket-launched, air-breathing missile, it is considered to have range, accuracy and load carrying capabilities as good as ballistic missile types.

RASCAL (TAM-63) long-range guided missile under development by Bell Aircraft Corporation, is a rocket-powered pilotless bomber designed to be carried by strategic bombers and released miles from objective to proceed at high speed to target.

BOMARC (IM-99) long-range interceptor guided missile of supersonic speed, is under development by Boeing Airplane Company. Successful experimental launchings at Patrick Air Force Base are now a regular part of the development program. A pilotless guided missile powered by Marquardt engine, it is launched from the ground and designed to seek out and destroy enemy aircraft at great distances from its launching site.

INTERCONTINENTAL BALLISTIC MISSILES include the ATLAS and TITAN ICBM. Convair Division of General Dynamics Corporation received a development contract for airframe and air frame components for the ATLAS ICBM. A second development contract for airframe and air frame components for the TITAN ICBM was awarded to Glenn L. Martin Company. Separate contracts were awarded to prime contractors for sub-components such as guidance system, propulsion and other sub systems. Many of the major components and sub systems will be identical for the ICBM–IRBM which is expected to accelerate their development and greatly reduce the overall cost of the ICBM–IRBM program.

INTERMEDIATE RANGE BALLISTIC MISSILE, THOR IRBM. Douglas Aircraft Company was awarded a development contract for the THOR IRBM in December 1955. Separate contracts were awarded to prime contractors for sub-components such as guidance system, propulsion and other sub-systems. Many of the major components and sub-systems will be identical for the ICBM–IRBM which is expected to accelerate their development and greatly reduce the overall cost of the ICBM–IRBM program.



Transferring the Intermediate Range Ballis concept to working reality is the prio ity ta

Army B

Major General J. B. Medaris

THE ARMY Ballistic Missile Agency (ABMA) at Huntsville, Alabama, is an organization unique in the annals of the United States Army. As is usual in the case of an unusual organization, it was brought into being to fill a critical and specific need.

Assignment to the Army by the Secretary of Defense of the major and top priority task of developing and perfecting an Intermediate Range Ballistic Missile for use from both land and sea-borne platforms, and the short time allotted for that task, created the need for such an organization.

The selection of the Army Ordnance Corps as the primary agency to undertake this important task was based on the fact that the existing Army Redstone missile program provided not only proof of competence and practical background, but also a going technical organization with useful specialized facilities and hardware already in manufacture which could be used to accelerate the perfection of the new missile. These same conditions established the obvious fact that it was impossible to separate the development of the new missile from the Redstone missile program, but must in fact be completely integrated with it in order to secure maximum value from the momentum already achieved.

Based on a directive from the Secretary of Defense to tackle this new task with all available resources, and with maximum urgency, the Army embarked on the course of action which resulted in the formation and activation on 1 February 1956 of the Army Ballistic Missile Agency at Redstone Arsenal. The development team, headed by Dr. Wernher von Braun, which had established such an outstanding reputation through the successful development and flight test of Redstone, became the nucleus around which the Agency was built.

MAJOR GENERAL JOHN B. MEDARIS is Commanding General, Army Ballistic Missile Agency, Huntsville, Ala.

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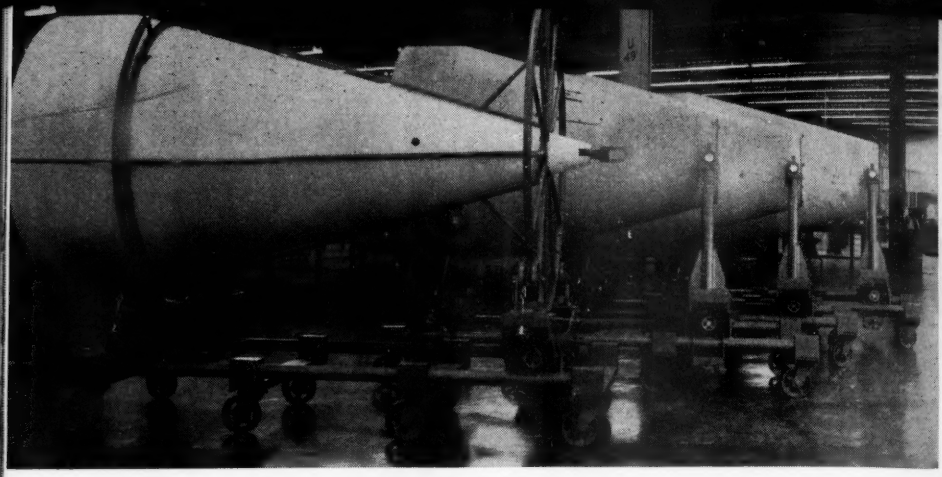
SINCE there are many time-consuming actions in the normal translation of a development project from the drawing board to operational hardware, each factor was examined to determine what could be done to reduce decision time and to expedite reaction. For example, a complete ballistic missile system involves technical responsibilities within the mission assignments of the Corps of Engineers, Signal Corps, Transportation Corps, and other technical services, in addition to the weapon development responsibilities of the Ordnance Corps.

Similarly for the ship-borne application, the Navy has definite responsibility. Hence with the across-the-board Army team representing the combat arms and other technical services, the Navy has on-the-spot participation. Thus we assure that the resulting weapon system will be fully and completely responsive to the needs of field commanders, providing close coordination between the developing and producing agency and the responsible users.

NORMALLY coordination in the development of a missile is somewhat time-consuming, due to distances involved. To reduce these delays to a minimum and to permit immediate and continuing assessment of all pertinent factors, the Chief of Staff directed that there be included in the Agency highly qualified and experienced officers, specially selected by those organizations and agencies which would normally participate in long range coordination, who could advise the Commanding General, ABMA, with respect to the interests, policies and requirements of these several responsible Army activities.

As a result, the Agency developed a compact and fast reacting organization, including a tactical and logistical staff headed by an experienced Artillery officer selected for the assignment by the Commanding General, CONARC. The Agency's Engineer Office, staffed by the Chief of Engineers with highly experienced personnel, and the Signal Office, staffed with top quality personnel by the Chief Signal Officer, provide skills and capabilities needed in both the tactical and technical areas of their respective services.

To place the requirements for the new missile in proper perspec-



Ready to be attached to the body of a Redstone missile, nose portions are assembled at Chrysler Corporation missile plant . . .

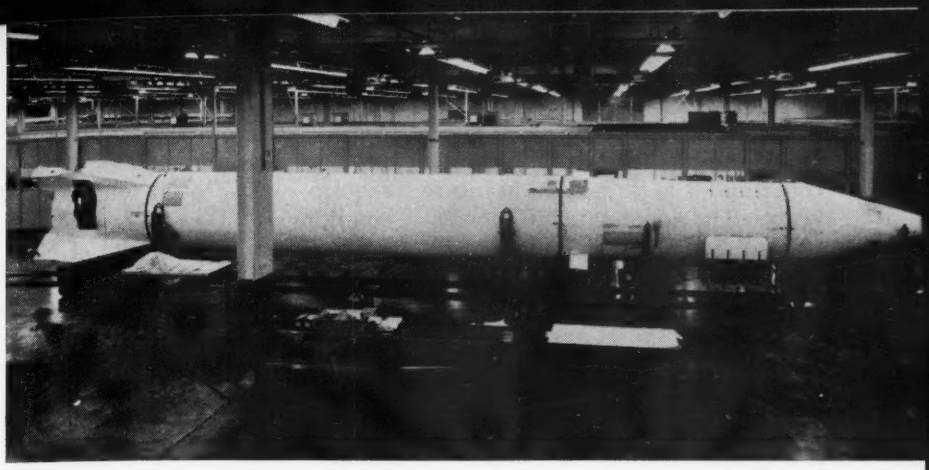
tive and to assure its applicability for both land and sea use, the closest relationship with the Navy was required. Responsibility for development of all sea-borne equipment was assigned to the Navy Bureau of Ordnance. Traditionally, this close working relationship between Army Ordnance and the Navy Bureau of Ordnance has existed for many years, and has resulted in efficient collaboration and common use by both services of many items of combat equipment. The organizational structure was finally complete when the Navy provided the Agency with a highly qualified group of uniformed and civilian representatives to maintain a direct and immediate channel for technical coordination.

To further couple responsibility with authority, and to obviate delay, the Secretary of the Army delegated to the Commanding General, ABMA, through the Chief of Ordnance, practically every authority in the development and procurement fields which could be delegated by the Secretary under the provisions of law and Department of Defense regulations. In effect, this unique and direct fixing of responsibility virtually eliminates delays except for those necessarily involved in securing funds and approvals from the Department of Defense level.

ALL of these actions were completed in record time. Actual operation of the Agency as a separate activity began on 1 February 1956. Today, the organization is a completely staffed, well-rounded activity, carrying out all of those varied activities required to assure that a complete, reliable, practical, effective and integrated weapon system will be turned over for field use at the earliest possible date.

Some of the operations currently underway include:

- Transfer of the major responsibilities in the weaponization of Redstone from the development team to the prime contractor in order that development efforts may be concentrated on the new missile.
- Assignment of major responsibility for final engineering work on the Redstone system to the prime contractor with the assistance and



. . . and soon the completed missile is moving off the assembly line, ready for a simulated flight test with all components operating as a unit.

supervision of the industrial organization of the Agency.

- Providing maximum non-scientific, technical, and administrative support to the development team.
- Establishment of close coordination with other interested agencies with respect to operational suitability and engineer user tests of Redstone.
- Providing initial training of operational Redstone units.
- Utilization of all pertinent Army resources to solve problems related to the ballistic missile program, including the discovery and elimination of all obstacles which possibly could interfere with or delay the hardware availability and flight test schedules established to assure availability of the new missile at the earliest possible date.

ANY view of the future must take cognizance of the major problems involved in the development of large ballistic missiles and the position of those missiles in the future security of the United States. Obviously, the effectiveness of future defensive and offensive military operations will be greatly dependent upon providing new means for the accurate delivery of destruction on selected targets at ever increasing distances.

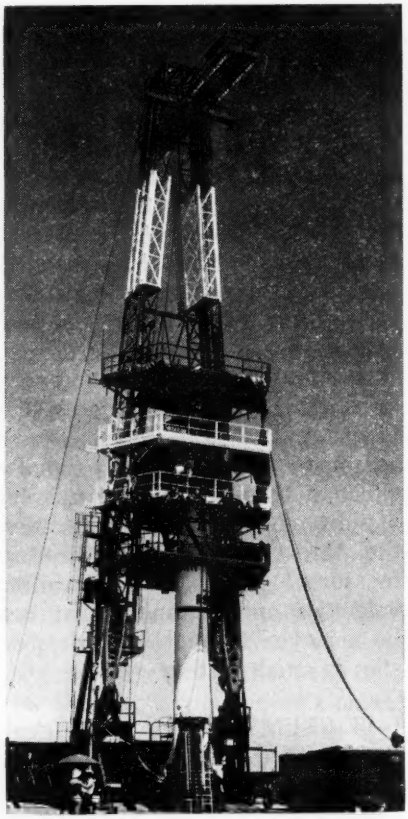
The airplane, as a delivery vehicle for means of destruction, faces continually increasing hazards and threats to its effectiveness through the perfection of present and clearly anticipated means of defense through surface-to-air missiles. The only other delivery vehicle potentially capable of executing long-range destruction missions is the ballistic missile. While presently known countermeasures can soon become almost wholly effective against airborne missiles of subsonic or near-sonic velocities, the threat of effective countermeasures against the extreme velocities and distances that can be achieved through ballistic missiles is much further away.

IT SEEMS obvious and urgent, therefore, that the Nation's development and weaponization program must look to a family of ballistic missiles of varying sizes and ranges, if the capability to deliver effective destruction on se-

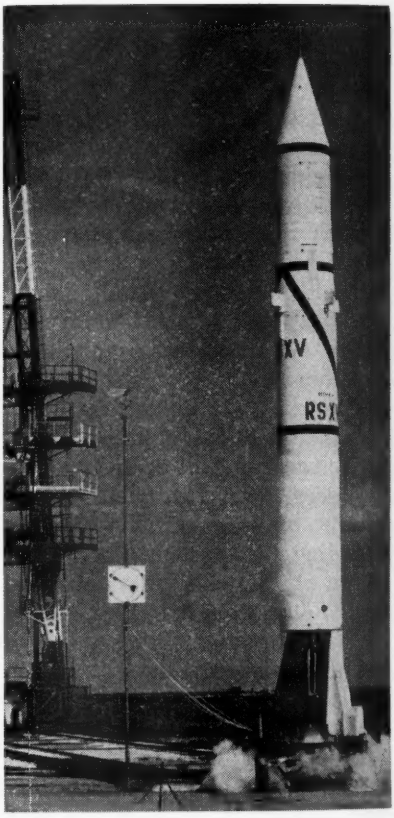
lected targets under all weather conditions is to be assured in future years. The proximate weaponization of Redstone, the early availability of the Intermediate Range Ballistic Missile, and the Air Force work on the ICBM are important steps toward the fulfillment of this requirement.

In any consideration of weapons systems, continuity of development effort is a most important feature. The transition from concept to actual hardware availability for field use is a long process; in the case of complex weapons systems, such as ballistic missiles, it may require years, even under ideal conditions.

To maintain continuity of effort, it is of paramount importance that work be underway simultaneously in at least three stages of time. Maximum progress, and the ability to exploit technical breakthroughs as rapidly as they occur, demand that there be underway concurrently:



***READY** for launch, a Redstone missile gets a last minute check, then it's . . .*

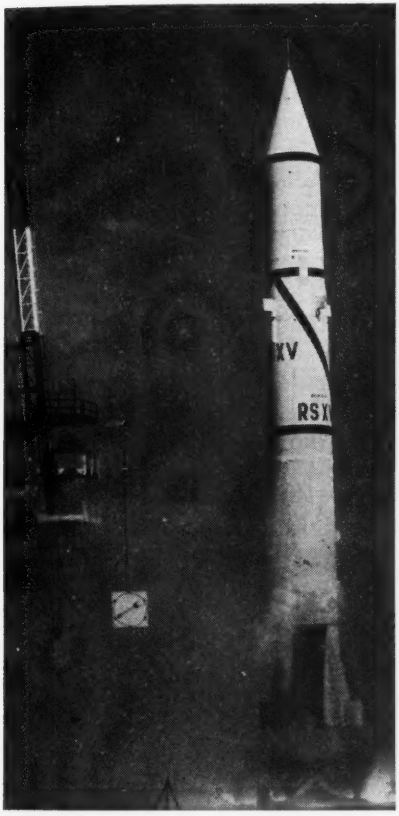


***GOING** slowly at first . . .*

- A missile in translation from an advanced state of development to production and field use.
- Another missile, using the momentum of the above as a spring-

board, being translated into hardware development.

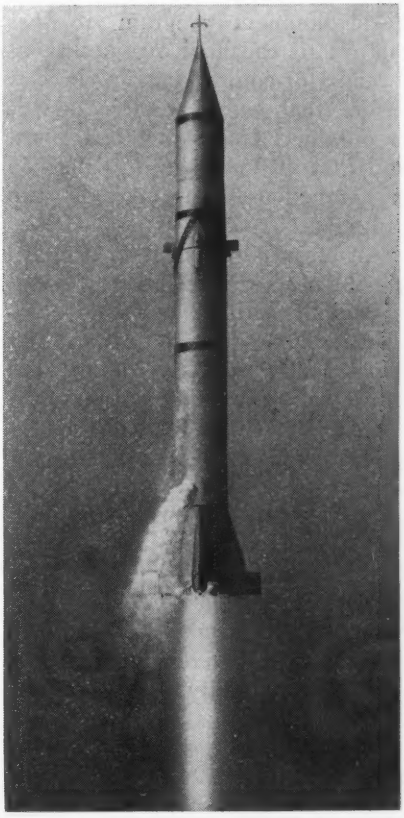
● A third project embracing the development of new components and the feasibility of combining them into needed weapons systems.



GOING now with fiery blast . . .

Failure to participate simultaneously in any one of these three stages inevitably results in a lack of continuity in development which can be cured only by a time-consuming retracing of steps.

UNDERLYING the specific work of the Army Ballistic Missile Agency is a basic philosophy for development, and a consistent plan



GONE at supersonic speed to deliver its powerful warhead.

for the application of all resources in areas of special difficulty. This development philosophy is based on accepting those risks where the odds in favor of success are high and avoiding the taking of chances where initial failure would result in an unacceptable delay.

Exhaustive laboratory and static testing is therefore conducted *before* flight tests in order to assess the probability of success and to clear up major problem areas before the expensive test vehicles are consumed by actual launching. While this sometimes may appear to slow down the initial phases of

a development program, it does not retard the final availability of a ready-for-combat missile. It *does* assure that every possible benefit is obtained from each test flight and that all knowledge so derived is immediately translated into progress.

An essential element in expediting the process from drawing board to combat readiness is the development of production capabilities concurrently with the design and testing of the missile system. The ABMA development team is responsible for design and pure development prototypes of hardware. However, prime contractors and major subcontractors are brought into the program from the very beginning to follow the development cycle and take over the production of hardware as soon as any degree of stability is established.

DURING the development process, special agencies inside and outside the Armed Forces, including arsenals, laboratories, universities, and research agencies, are used on a task basis to accelerate solutions to selected specific problems. The results of all these efforts are constantly made available by means of close technical coordination to assure that the missile system is considered as a whole, and not as a group of unrelated components which may be incompatible and hence result in failure when used in a weapon system.

Under the present top priority program of the Agency, the closest possible coordination is effected on a continuing basis with the responsible Navy and Air Force agencies involved in the ballistic missile program. Through a net of field offices physically located with the Special Projects Office of the Navy Department, the Air Force Western Development Division, and the Air Force Missile Test Center at Cape Canaveral, Florida, a constant flow and exchange of technical information is maintained. The continuing operations of highly capable Army-Navy technical coordinating committees insure that the developed missile system will meet Navy needs.

An important factor in assuring success within the established time scale is the ability to discover difficulties and problems while there is still time for remedial action. To provide this essential early warning, an effective control system with direct communications to key points throughout the United States continually evaluates progress at every point in the program and determines the effect of potential obstacles. Early discovery results in the flashing of warning lights. The operation of this highly developed control center has already proven its value by pointing up interferences, forgotten areas, and potential delays six to seven months before their consequences would have been felt in terms of delaying the program. With this advanced warning it is a simple matter to concentrate the resources required to eliminate the interference.

RECOGNIZING that the ballistic missile field is in its infancy, ABMA is looking as far as possible up the road to the future. As part and parcel of this outlook it emphasizes the need for coordinated and continuing consideration in the following areas in order that the end-product of our efforts will be

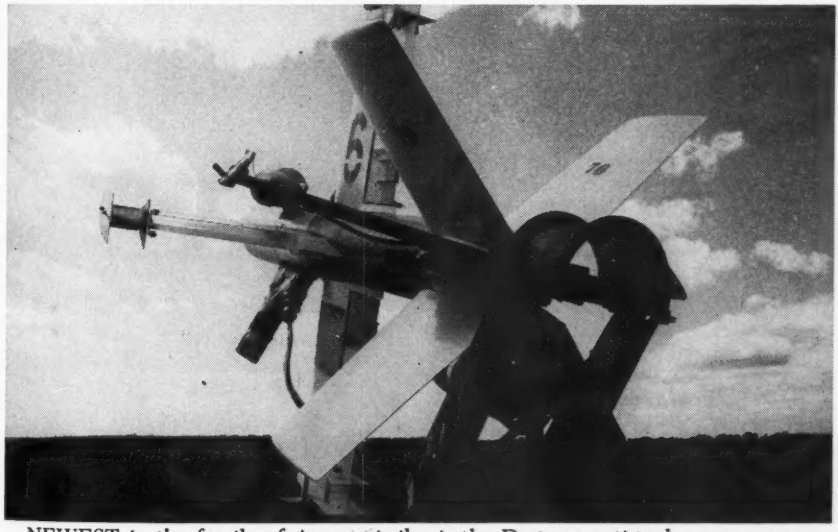
a ballistic missile system which will meet in all respects the operational requirements of field commanders:

- All factors pertaining to tactical applications and user requirements.
- The impact of ballistic missile systems on logistics and the effect of logistics on operational use of ballistic missiles.
- The requirements of policy making agencies of the Army, CONARC and CONARC Boards.

Similar actions by, and close coordination with, the Navy, guarantees that these modern weapons will meet Navy operational requirements. In this connection, meeting the Navy's requirement for missile performance from shipboard definitely insures the capability to employ the new missile from a stable land-based platform.

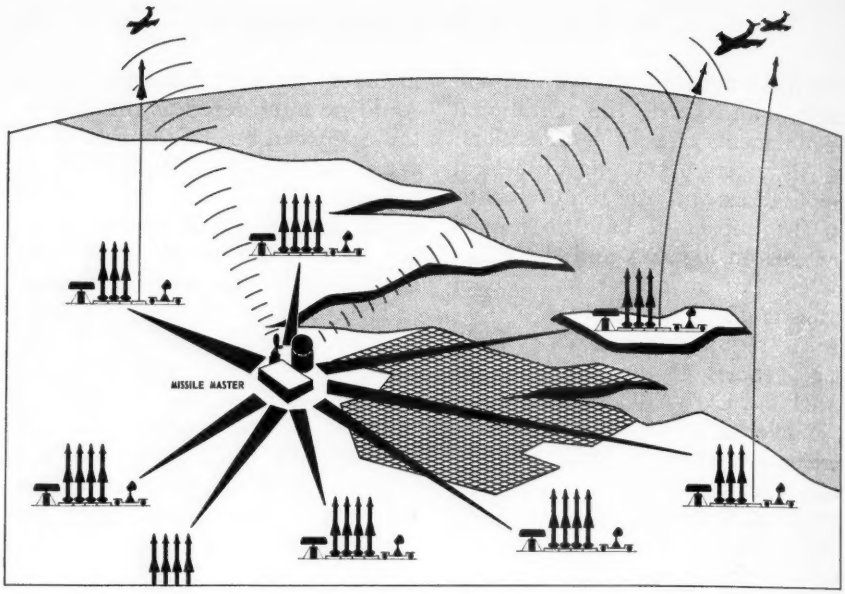
While it might appear that the logistic support for these weapons involves unique features which could be interpreted as difficulties, the Army can be assured that there are no insurmountable problems in the operational use of modern liquid propelled ballistic missiles in any area of the world where their destructive power may be needed.

The Army Ballistic Missile Agency is looking forward to full exploitation of the most advanced capabilities of science to produce practicable and usable weapons now and in the future. We are confident that the ballistic missiles now under development have the inherent capability for accurate delivery of any available type of destruction on any selected target under any and all conditions of weather and terrain. Against that conviction and that requirement we continually evaluate our work and our progress.



NEWEST in the family of Army missiles is the Dart, an anti-tank weapon system which has been placed into production. A simple but effective anti-tank missile, it is designed with the high probability that a single hit would destroy a heavily armored tank. The weapon will be employed by infantry or armored combat units.

The Dart is about five feet long with a configuration characterized by fins crossing its waistline. Propelled by a rocket motor containing smokeless propellant, it is sufficiently maneuverable to make it relatively safe from rifle, machine gun, antiaircraft fire.



Missile Master for Antiaircraft Defense

A COMPLETE electronic system for coordinating and directing a large number of Nike guided missile firing batteries—and other advanced Army weapons as they become available—has been perfected after ten years of research and development. In effect, the system ties together all elements of antiaircraft defense from target detection to target destruction, to achieve maximum effectiveness in firing of all Nike and other antiaircraft weapons at any given location.

Known as Missile Master, the system collects information on location of aircraft and their identity, presents this information on electronic screens and distributes the data to the missile firing batteries.

Thus each Nike battery can receive a continuous flow of fresh data on all aircraft within the defense areas, and reports on what all other batteries are doing as well. Each battery commander can then make proper selection of a target.

Seated at electronic consoles, Missile Master operators can observe activities of all batteries in the system, and can direct a specific fire unit to a particular target if it is deemed necessary to do so. They can also protect friendly aircraft from being fired upon by Nike weapons.

Work on the system was started by Army Signal Corps in 1945. By 1950 a forerunner of Missile Master was installed at Fort George G.

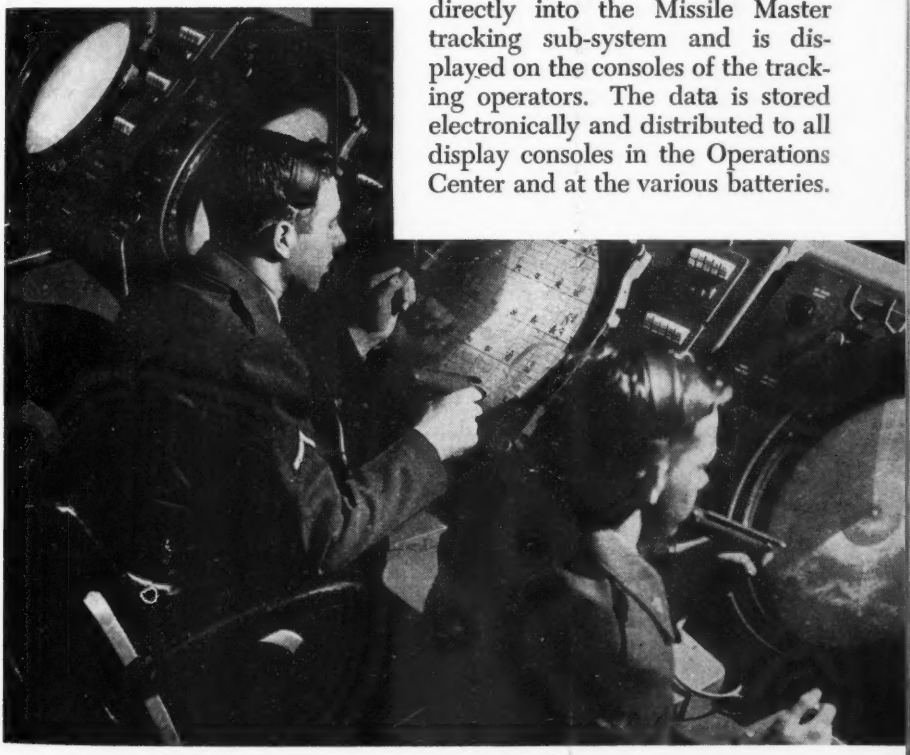
Meade, Maryland, where it has been in experimental operation for almost two years. Glenn L. Martin Company was principal contractor, aided by the Airborne Instruments Laboratory and the American Machine and Foundry Company.

EACH SYSTEM consists primarily of an automatic data communications network, and of automatic data processing and display equipment, with human supervision imposed at the most critical points. Systems at key antiaircraft installations throughout the United States, will operate in conjunction with units of the recently announced Air Force semi-automatic ground environment area defense system known as SAGE. These units are also designed to operate independently when necessary.

Focal point of Missile Master is the Operations Center, where operators at radar-type display consoles have a view of the entire air situation in the local area, as well as information on activities of the Nike batteries under their control. Surveillance and height-finding radar, which provide independent search and surveillance facilities, are installed on towers adjacent to the building.

Target information—including position, identity, velocity data, size of the target, and the like—passes directly into the Missile Master tracking sub-system and is displayed on the consoles of the tracking operators. The data is stored electronically and distributed to all display consoles in the Operations Center and at the various batteries.

Electronics consoles like these radar entry consoles in use at Fort George G. Meade, are the heart of the Missile Master system.



A Glossary of GUIDED MISSILE TERMS

ACCELEROMETER—an instrument that measures one or more components of the accelerations of a vehicle.

AERODYNAMICS—that field of dynamics which treats of the motion of air and other gaseous fluids and of the forces acting on solids in motion relative to such fluids.

AFTERBURNING—the process of fuel injection and combustion in the exhaust jet of a turbojet engine (after the turbine).

AILERON—a hinged or movable surface on an airframe, the primary function of which is to induce a rolling moment on the airframe. It usually is part of the trailing edge of a wing.

AIRFOIL—any object whose geometric shape is such that when properly positioned in an airstream will produce a useful reaction.

ALTIMETER—an instrument that measures elevation above a given datum plane.

AMPLIFIER—a device for increasing magnitude of the electrical or mechanical output of a system, as in radio, electrical, pneumatic, audio and hydraulic systems.

ANGLE OF ATTACK—the angle between a reference line fixed with respect to an airframe and the apparent relative flow line of the air.

ANTENNA—a device—i.e., conductor, horn, dipole—for transmitting or receiving radio waves, exclusive of the means of connecting its main portion with the transmitting or receiving apparatus.

ARMING—as applied to fuzes, the changing from a safe condition to a state of readiness. Generally a fuze is caused to arm by acceleration, rotation, clock mechanism, or air travel, or by combinations of these.

AIR-BREATHING JET—a propulsion device which operates by taking in air and then ejecting it as a high-speed jet.

ATTENUATOR—a device designed to cause a loss in energy in a system without introducing appreciable distortion in the desired frequencies.

ATTITUDE—the position of an aircraft as determined by the inclination of its axes to some frame of reference.

AUDIO—pertaining to frequencies of audible sound waves between about 20 and 20,000 cycles per second.

AUTOMATIC GAIN CONTROL (AGC)—a circuit, also called the Automatic Volume Control, which automatically varies the over-all amplification, inversely proportional to input signal strength changes, such that the output volume of the receiver remains constant.

AUTOMATIC PILOT—an automatic control mechanism for keeping an aircraft in level flight and on a set course or for executing desired maneuvers. Sometimes called gyropilot, mechanical pilot, robot pilot, or auto pilot.

BALLISTIC MISSILE—a vehicle whose flight path from termination of thrust to impact has essentially zero lift. It is subject to gravitation and drag, and may or may not perform maneuvers to modify or correct the flight path.

BAND, FREQUENCY—in communications and electronics, a continuous range of frequencies extending between two limiting frequencies.

BANDWIDTH—the difference in frequencies between the lowest and highest frequency parameters of a circuit, such as tuned circuit, modulated radio signal, servo-mechanism, or radio station channel assignment.

BEACON, RADAR—generally, a nondirectional radiating device, containing an automatic radar receiver and transmitter, that receives pulses ("interrogation") from a radar, and returns a similar pulse or set of pulses ("response"). The beacon response may be on the same frequency as the radar, or may be on a different frequency.

BOOSTER—an auxiliary propulsion system which travels with the missile and which may or may not separate from the missile when its impulse has been delivered.

CANARD—a type of airframe having the stabilizing and control surfaces forward of the main supporting surfaces.

CENTER OF GRAVITY—the point at which all the mass of a body may be regarded as being concentrated, so far as motion of translation is concerned.

CHANNEL—in radio communications, the band of frequencies within which a radio transmitter or receiver must maintain its modulated carrier signal.

CLUTTER, RADAR—the visual evidence on the radar indicator screen of sea-return or ground return which tends to obscure the target indication.

COAXIAL LINE—a cable having concentric conductors. Used as a transmission line for audio, radio, radar, and television signals.

COMPUTER—a mechanism which performs mathematical operations.

CONICAL SCANNING—a radar scanning system wherein a point on the radar beam describes a circle at the base of a cone, and the axis is the generatrix of the cone.

CONTROL, BANG-BANG—a control system used in guidance wherein the corrective control applied to the missile is always applied to the full extent of the servo motion.

CONTROL, PROPORTIONAL—control in which the action to correct an error is made proportional to that error.

DAMPING—the effect of friction or its equivalent in reducing oscillation of a system.

DESTRUCTOR—an explosive or other device for intentionally destroying a missile, an aircraft, or a component thereof.

DIFFUSER—a duct of varying cross section designed to convert a high-speed gas flow into low-speed flow at an increased pressure.

DISH, RADAR—the parabolic reflector which is part of certain radar antennas.

DOPPLER EFFECT—the apparent change in frequency of a sound or radio wave reaching an observer or a radio receiver, caused by a change in distance or range between the source and the observer or the receiver during the interval of reception.

DRAG—that component of the total air forces on a body, in excess of the forces owing to static pressure of the atmosphere, and parallel to the relative gas stream but opposing the direction of motion. It is composed of skin-friction, profile-, induced-, interference-, parasite-, and base-drag components.

DUCTED PROPULSION—generally refers to any propulsion system which passes the surrounding atmosphere through a channel or duct while accelerating the mass of air by a mechanical or thermal process.

GATE—(1) In radar or control terminology, an arrangement to receive signals only in a small, selected fraction of the principal time interval. (2) Range of air-fuel ratios in which combustion can be initiated. (3) In computer terminology, a device used to control passage of information through a circuit.

GIMBAL—a mechanical frame containing two mutually perpendicular intersecting axes of rotation (bearings and/or shafts).

GUIDANCE—the entire process of determining the path of a missile and maintaining the missile on that path.

GUIDANCE, BEAM RIDER—a guidance system in which equipment aboard the missile causes it to seek out and follow a path specified by a beam.

GUIDANCE, CELESTIAL NAVIGATION—navigation by means of observations of celestial bodies. A system wherein a missile, suitably instrumented and containing all necessary guidance equipment, may follow a predetermined course in space with reference primarily to the relative positions of the missile and certain preselected celestial bodies.

GUIDANCE, COMMAND—a guidance system wherein intelligence transmitted to the missile from an outside source causes the missile to traverse a directed path in space.

GUIDANCE, HOMING—a system in which a missile steers toward a target by means of radiation which the missile receives from the target, either by

reflection (radar or visible light) or by emission from the target (infra-red or acoustic energy).

GUIDANCE, HOMING, ACTIVE—a form of guidance wherein both the source for illuminating target and the receiver are carried within the missile.

GUIDANCE, HOMING, PASSIVE—a system of homing guidance wherein the receiver in the missile utilizes natural radiations from the target.

GUIDANCE, HOMING, SEMIACTIVE—a system of homing guidance wherein the receiver in the missile utilizes radiations from the target which has been illuminated from a source other than in the missile.

GUIDANCE, INERTIAL—a form of guidance in which all guidance components are located aboard the missile. These components include devices to measure forces acting on the missile and generating from this measurement the necessary commands to maintain the missile on a desired path.

GUIDANCE, MIDCOURSE—the guidance applied to a missile between the termination of the launching phase and the start of the terminal phase of guidance.

GUIDANCE PRESET—a technique of missile control wherein a predetermined path is set into the control mechanism of the vehicle and cannot be adjusted after launching.

GUIDANCE, RADIO NAVIGATION—a form of guidance in which the path of the missile is determined by a time measurement of radio signals.

GUIDANCE, TERMINAL—the guidance applied to a missile between the termination of the midcourse guidance and impact with or detonation in close proximity of the target.

GUIDANCE, TERRESTRIAL REFERENCE—a technique of missile control wherein the predetermined path set into the control system of a missile can be followed by a device in the missile which reacts to some property of the earth, such as magnetic or gravitational effects.

GUIDED MISSILE—an unmanned vehicle moving above the earth's surface, whose trajectory or flight path is capable of being altered by a mechanism within the vehicle.

GYROSCOPE—a wheel or disc, mounted to spin rapidly about an axis and also free to rotate about one or both of two axes perpendicular to each other and to the axis of spin. A gyroscope exhibits the property of rigidity in space.

HUNTING—a condition of instability resulting from over-correction by a control device and resultant fluctuations in the quantity intended to be kept constant.

HYPERGOLIC—capable of igniting spontaneously upon contact.

ILLUMINATOR, TARGET—a transmitting device on a missile or off that is used in guiding on the target.

INTERCONTINENTAL BALLISTIC MISSILE (ICBM)—a ballistic missile which has a range of approximately 5000 nautical miles.

INTERMEDIATE RANGE BALLISTIC MISSILE (IRBM)—a ballistic missile which has a range of approximately 1500 nautical miles.

IONOSPHERE—that portion of the earth's atmosphere, beginning about 30 miles above the earth's surface, which consists of layers of highly ionized air capable of bending or reflecting certain radio waves back to the earth.

JAMMING—intentional transmission of r-f energy, in such a way as to interfere with reception of signals by another station.

JATO—an auxiliary rocket device for applying thrust to some structure or apparatus.

JET—an exhaust stream or rapid flow of fluid from a small opening or nozzle.

JET PROPULSION—the force, motion or thrust resulting from the ejection of matter from within the propelled body.

LOBE—one of the three-dimensional portions of the radiation pattern of a directional antenna.

MACH NUMBER—the ratio of the velocity of a body to that of sound in the medium being considered. At sea level in air at the Standard U. S. Atmosphere, a body moving at a Mach number of one (M-1) would have

a velocity of approximately 1116.2 feet per second, the speed of sound in air under those conditions.

MISSILE—a self-propelled unmanned vehicle which travels above the earth's surface.

NOZZLE—a duct of changing cross section in which the fluid velocity is increased. Nozzles are usually converging-diverging, but may be uniformly diverging or converging.

PHOTOTHEODOLITE—a device for measuring and recording the horizontal and vertical angles to a missile while photographing its flight.

PITCH—an angular displacement about an axis parallel to the lateral axis of an airframe.

PROPELLANT—material consisting of fuel and oxidizer, either separate or together in a mixture or compound which if suitably ignited changes into a larger volume of hot gases, capable of propelling a rocket or other projectile.

PULSE—a single disturbance of definite amplitude and time length, propagated as a wave or electric current.

RAMJET—a compressorless jet-propulsion device which depends for its operation on the air compression accomplished by the forward motion of the unit.

ROCKET—a thrust-producing system or a complete missile which derives its thrust from ejection of hot gases generated from material carried in the system, not requiring intake of air or water.

ROLL—an angular displacement about an axis parallel to the longitudinal axis of an airframe.

SEEKER, TARGET—a receiving device on a missile that receives signals emitted from or reflected off the target that is used in guiding on the target.

SIGNAL—any wave or variation thereof with time serving to convey the desired intelligence in communication.

SONIC—velocity that is equal to the local speed of sound.

SPECIFIC IMPULSE, FUEL—thrust developed by burning one pound of fuel in one second, or the ratio of thrust to the fuel mass flow.

SPEED OF SOUND—the velocity at which sound waves are transmitted through a medium. Speed of sound in the air varies as the square root of the absolute temperature. (*See* "Mach Number.")

SQUIB—a small pyrotechnic device which may be used to fire the igniter in a rocket or for some similar purpose. Not to be confused with a detonator which explodes.

SUBSONIC—a velocity less than the local speed of sound, or than a Mach number of one.

SUPERSONIC—a velocity that is greater than the local speed of sound.

SUSTAINER—a propulsion system which travels with and does not separate from a missile, usually distinguished from an auxiliary motor, or booster.

TELEMETERING SYSTEM—the complete measuring, transmitting, and receiving apparatus for remotely indicating, recording, and/or integrating information.

THEODOLITE—an optical instrument for measuring horizontal and vertical angles with precision.

THROAT—in rocket and jet engines, the most restricted part of an exhaust nozzle.

THRUST—the resultant force in the direction of motion, owing to the components of the pressure forces in excess of ambient atmospheric pressure, acting on all inner surfaces of the vehicle parallel to the direction of motion. Thrust less drag equals accelerating force.

TRANSONIC—the intermediate speed in which the flow patterns change from the subsonic flow to supersonic, i.e. from Mach numbers of about .8 to 1.2, or vice versa.

TURBOJET—a jet motor whose air is supplied by a turbine-driven compressor; the turbine being activated by exhaust gases from the motor.

YAW—an angular displacement about an axis parallel to the "normal" axis of an aircraft.

TECHNICAL SERVICES SUPPORT THE ARMY MISSILE PROGRAM

AN EXPANDING missile effort by the Army has meant expanding fields of endeavor by the Signal Corps, both in the area of research and development of new communications facilities, and the installation of existing equipment and facilities to support efforts of other agencies.

In the area of research and development, the Signal Corps currently is working on electronic components for guided missiles, instrumentation for guided missile ranges, and communication and electronic systems for integration and coordination of weapons used in antiaircraft defense.

One project is a joint research program designed to determine the characteristics of the upper atmosphere, data on which is necessary to the successful conduct of the entire guided missile program. Another important project is the study of vulnerability of Army guided missile systems to electronic countermeasures.

The Corps is also responsible for the research and development of fire direction systems. Already completed is Missile Master, a complete electronic system for coordination and direction of a large number of Nike firing batteries.

THE SIGNAL CORPS operates and maintains a range communication and data transmission system, a chain radar tracking system and a frequency coordination service in support of the guided missile program.

All fixed communication facilities used at antiaircraft defense sites in the continental United States come under direction of the Signal Corps. This includes operational networks interconnecting the Nike guided missile battery with the Antiaircraft Operation Center.

The Signal Corps has provided the Army Ballistic Missile Agency with an intercontinental network of private lines for both voice and teletypewriter communications to facilitate its day-to-day efforts in developing the Jupiter missile. Telephone and other communication facilities currently are being expanded at Redstone Arsenal, where a communication system for air navigation has also been installed.

The Corps also provides television equipment and technicians for conducting tests in the application of television.

QUARTERMASTER CORPS research and development in support of the Army missile program includes studies in the fields of material handling equipment, liquid fuel dispensing and handling equipment, field heating, tentage, decontamination of clothing and personal equipment, and special rations.

Already developed is a protective clothing ensemble to reduce hazards from burns that might be caused by liquid fuels. Made of vinyl-coated fiberglass, these garments prevent the fuels and oxidizers from coming in contact with the skin.

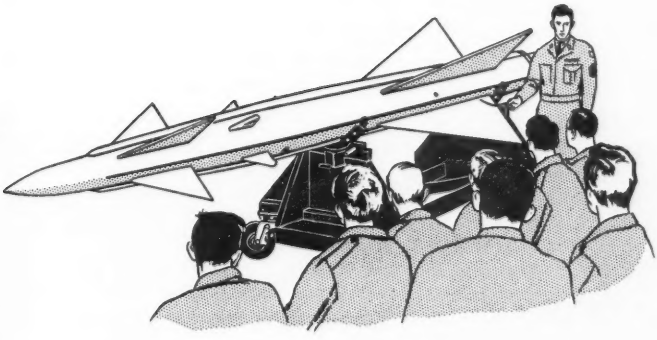
More recently an improved protective ensemble has been designed of modified butyl-coated fabric. Although still in the experimental stage, these new garments give strong indications of affording even better protection against burns. Efforts also are being made to provide greater comfort under hot weather conditions.

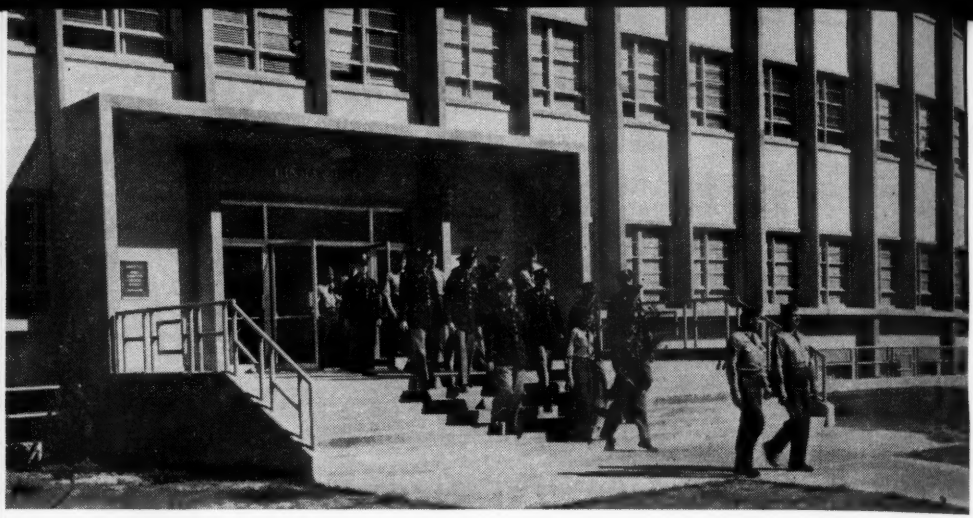
THE CHEMICAL CORPS is developing supplied air masks for use by personnel engaged in handling of toxic chemical fuels for missiles. Research and studies are also being conducted on the toxicological hazards of missile liquid fuels and their exhaust products.

THE CHIEF OF TRANSPORTATION, by close coordination with the Army Ballistic Missile Agency and Redstone Arsenal personnel, is actively participating in matters affecting handling, loading and movement of new and current missiles, and various components. Great strides have been made toward holding sizes and weights of the Army guided missile systems within reasonable world transportation capabilities of handling, loading and movement or shipment, without impairing their effectiveness.

III. The Men and their Training

"All Army personnel must acquire a sound understanding of missiles and their application to ground combat operations."





At the Antiaircraft Artillery and Guided Missile Center, skilled men are organized into "package" teams following

NIKE AND CORPO

Major General Robert J. Wood

MISSILE AWAY!

The launcher crew crouches behind its revetment; the fire control team is glued to its instruments; all others gaze skyward in awe and admiration as a powerful blast sends the rocket streaking skyward!

Here are men dealing with the Army's latest "hardware," with the tremendously destructive weapons of the future—Nike I, first of a family of surface-to-air guided missiles, and the Corporal, first surface-to-surface guided missile with the required degree of accuracy for the support of ground forces. Many supersonic weapons of destruction have been tested, but these are the first two operational guided missiles in the hands of Army troop units.

Only a few years ago these fantastic weapons were beyond the wildest dreams of all but the most far-sighted scientists and military men. Only a few months ago, it seems, responsible authorities were saying that so far we still had only the button of the push-button era of warfare. But, here they are now —manned by trained personnel and ready to expend their lethal power against anyone who would threaten the Nation's security.

MAJOR GENERAL ROBERT J. WOOD is Commanding General, Antiaircraft Artillery and Guided Missile Center, and Commandant, Antiaircraft Artillery and Guided Missile School, Fort Bliss, Texas.

PORAL TRAINING

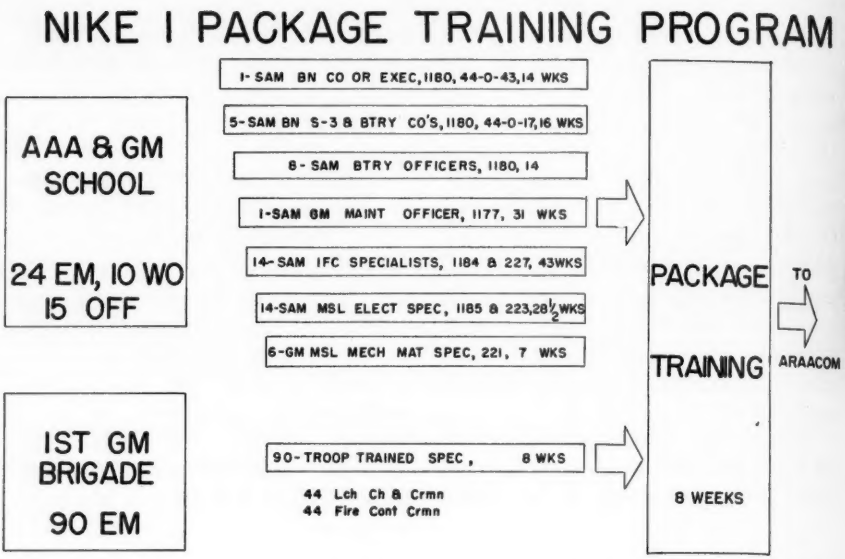
But any weapon, it must be remembered, is only as good as the man using it. People are still our most important commodity—and the least publicized. New research and development items are quick to bring new headlines; and this in turn frequently evokes in the public mind a feeling that the equipment is already being manned. Often forgotten is the necessity for training both individuals and units to man this new equipment.

Here at the Antiaircraft Artillery and Guided Missile Center, at Fort Bliss, Texas, training is our business. Most of the personnel manning Nike and Corporal units both in the Continental United States and overseas have been trained here.

What is this training like? How is a guided missile unit formed? How is the soldier without previous experience in guided missiles taught to become a missileman? How would you, as an individual, fit into a Nike or Corporal unit?

Consider first the training of maintenance personnel as it is carried out by the Antiaircraft Artillery and Guided Missile School. This School is a big insti-

Demonstration of the power and accuracy of a Nike missile is watched by a class at Red Canyon Range.


NIKE I PACKAGE TRAINING PROGRAM
AAA & GM SCHOOL
24 EM, 10 WO
15 OFF
1- SAM BN CO OR EXEC, 1180, 44-0-43, 14 WKS
5- SAM BN S-3 & BTRY CO'S, 1180, 44-0-17, 16 WKS
8- SAM BTRY OFFICERS, 1180, 14
1- SAM GM MAINT OFFICER, 1177, 31 WKS
14- SAM IFC SPECIALISTS, 1184 & 227, 43WKS
14- SAM MSL ELECT SPEC, 1185 & 223, 28½ WKS
6- GM MSL MECH MAT SPEC, 221, 7 WKS
PACKAGE TRAINING
8 WEEKS
TO ARAACOM
1ST GM BRIGADE
90 EM
90- TROOP TRAINED SPEC, 8 WKS
44 Lch Ch & Crmn
44 Fire Cont Crmn

tution, with many courses of different types going on at all times. The total student load averages around 3,550, two-thirds of them enlisted personnel.

THE NIKE

LET US assume that you are arriving here for the 28-week course in electronic materiel maintenance. Your instruction begins in the Department of Electronics and Engineering, where you will learn basic electricity, radio, and radar electronics. Upon completion of these courses, you go to the Department of Guided Missiles for the more advanced and highly specialized training in the maintenance of the critical electronic parts inside the missile—"the brain" by which Nike responds to ground signals while in flight. At the end of 28 weeks you will be a specialist in the maintenance of this critical materiel.

While you have been studying electronics, other selected men are taking courses in mechanical maintenance in which they learn to assemble, fuel, test, and trouble-shoot mechanical aspects of the missile. Still others are taking courses in the maintenance of the fire control system in which they learn to maintain the elaborate ground equipment used to fire the Nike and guide it to its target.

These courses are not all of the same length. The longest one runs for 42 weeks.

While the AAA and Guided Missile School is training *maintenance* personnel, the 1st Guided Missile Brigade, also part of the Center, has been conducting a specialist program of eight weeks' duration. These specialists are the key *operators* in the Nike units.

Individual training phases at both the School and the Brigade terminate at the same time. This permits the immediate activation of a Nike "package."

A group of 124 key enlisted men and warrant officers will be the nucleus or cadre for a full-strength Nike battalion. When these individuals finish their training and

In Practice. *Installation of a warhead on a missile is demonstrated by an experienced sergeant-instructor.*

assemble as a unit, they are furnished the materiel for their Nike battalion, brand new and straight from the factory. Thirty-four of these enlisted men are graduates of the various school courses. Six are mechanical maintenance men; 14 are specialists in electrical maintenance; and 14 are trained in fire control. The remaining 90 enlisted personnel have completed the eight-week troop-trained specialist program of the 1st Guided Missile Brigade.

Fifteen officers, also newly graduated at the School, complete the "package."

The Nike package now devotes five weeks to a thorough checkout of its equipment and to tracking and drills. During this period, individual skills are put together to form the team. Then the cadre takes the field at Red Canyon Range for actual firing practice.

After each battery unit has successfully fired Nikes, the package proceeds to its already prepared position near one of our large centers of population. Here the School-trained and troop-trained specialists will train the other men who complete the battalion. Thus another link is forged in our chain of Nike units. (See "Manning Our Nike Sites," October 1955 DIGEST.)

THE CORPORAL

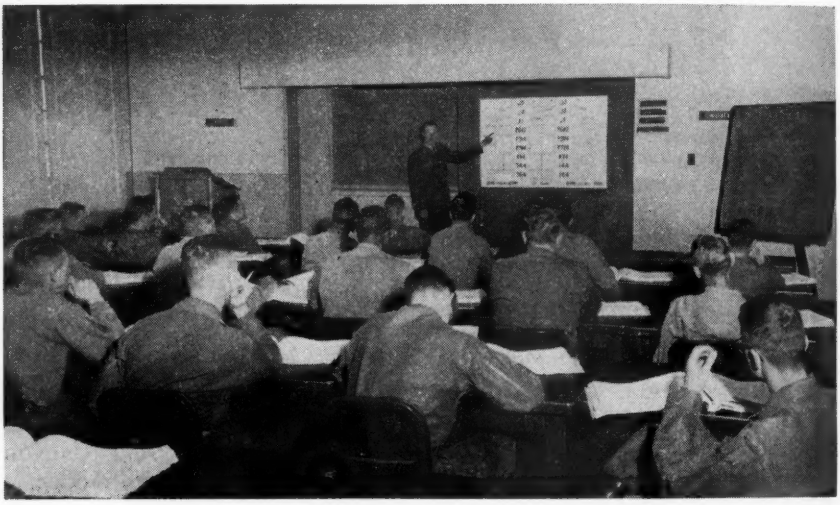
TRAINING on this surface-to-surface missile parallels the Nike training provided in the School and in the Brigade. Courses vary slight-

ly in their final details from those used in surface-to-air training. Instead of "packages" being trained, however, entire units are trained so that at the final phase a full-strength Corporal battalion of 22 officers and 224 enlisted men has been assembled.

At the School, instruction is given essentially by the same departments. At the Brigade, the 1st Guided Missile Group is responsible for Nike training, and the 2d Guided Missile Group for Corporal training.

Unit training of the Corporal battalion lasts twenty weeks and consists of several field problems, climaxed by missile firings at another range—Oro Grande. Here, as in Nike training, teamwork is sharpened and each man sees the importance of his job in the overall pattern. From here, Corporal battalions are assigned as Army Corps artillery and deployed to locations either within the Continental United States or overseas. At present, six Corporal battalions are in Europe and two others are en route to that theater.

In the field army the Corporal adds a greater meaning to artillery, increasing its potential to the extent that four fully equipped Corporal battalions exceed the entire fire power of *all* American artillery units in World War II. Corps and Army commanders now have at their disposal a weapon which can strike enemy targets at far greater ranges than artillery, and can completely destroy these targets, utilizing either high explosive or atomic warheads. Moreover, it can be fired day or night without regard to weather conditions.



In Classroom. *Men studying range systems learn intricacies of the ground guidance unit of Nike.*

QUALIFIED TRAINEES

ENLISTED MEN selected for Nike or Corporal training—either as operators or maintenance spe-

cialists—come from four groups:

First, enlistees who request guided missile training on enlistment;

Second, soldiers who apply for such training after completing basic training;

Third, career artillerymen who apply, through channels, for guided missile training; and

Fourth, reenlistees for guided missile training from throughout the Army.

Obviously, the School could not hope to turn out qualified maintenance personnel or operators within the allotted time unless the trainees possessed both the educational level and capacity to absorb the technical instruction. A phrase used to cover this prerequisite is "special aptitudes." That means a high school education, or its equivalent. It also means some training in algebra and trigonometry, as well as some background in general science. Finally, it means the attainment of a score of 100 or higher in those aptitude areas which indicate a general ability in electricity and mechanics and show whether or not an individual will be able to absorb technical training.

Not every man is eligible, but every man who really wants to get into the guided missile field can do so if he sets his mind to it. If he is deficient in educational requirements, he can acquire in off-duty hours the necessary educational platform on which to build a guided missile career.

The electronic materiel maintenance courses take 28 weeks. The fire control maintenance courses take 42 weeks for Nike and 32 weeks for Corporal. Applicants must be Regular Army members and have at least 20 months remaining of their current enlistment upon completion of training.

A shorter course of eight weeks, covering mechanical materiel maintenance of either Nike or Corporal, is open to enlisted men of Grade E-6 or below, who have at least 15 months to serve after completing the course.

Naturally, too, security clearances are required for all personnel.

OPERATOR training is conducted by the 1st Guided Missile Brigade in two general fields—fire control and launching. The Brigade eight-week operator training period is followed, in the case of Nike, by the package training and firing practice (for an additional eight weeks). In the case of Corporal units a 20-week unit training program follows. Replacements in either case join their units in lieu of package or unit training periods.

Regardless of which missile system (Corporal or Nike) or field of training (fire control or launching) is involved, the prerequisites are the same. The applicant must have attained a standard score of 90 or higher in applicable aptitude areas, must have 15 months or more to serve after completion of his training, and must have a security clearance.

OFFICER TRAINING

A TOTAL of 15 officers are included in the Nike package, and 22 officers comprise the T/O for a Corporal battalion. How are these officers trained?

Second lieutenants attend a basic course in either surface-to-surface or surface-to-air missiles. These courses last for approximately 17

weeks at the AAA and Guided Missile School and devote considerable time to operational techniques and practical work.

For the battery officers, there is a regular course which includes all types of weapons or an "associate" course in any one. These courses are open to almost any officer who desires to apply.

Field officers attend either one of the associate battery courses as a short course, or they attend an advanced course (either regular or associate).

The School conducts a multitude of courses, but three particularly are of main interest. These are the Nike or Corporal Maintenance Officer Courses which run for 31 weeks; the Guided Missile Staff Officer Course for 26 weeks; and finally, the Special Weapons and Guided Missiles Orientation Course (essentially for senior officers) which run for one week.

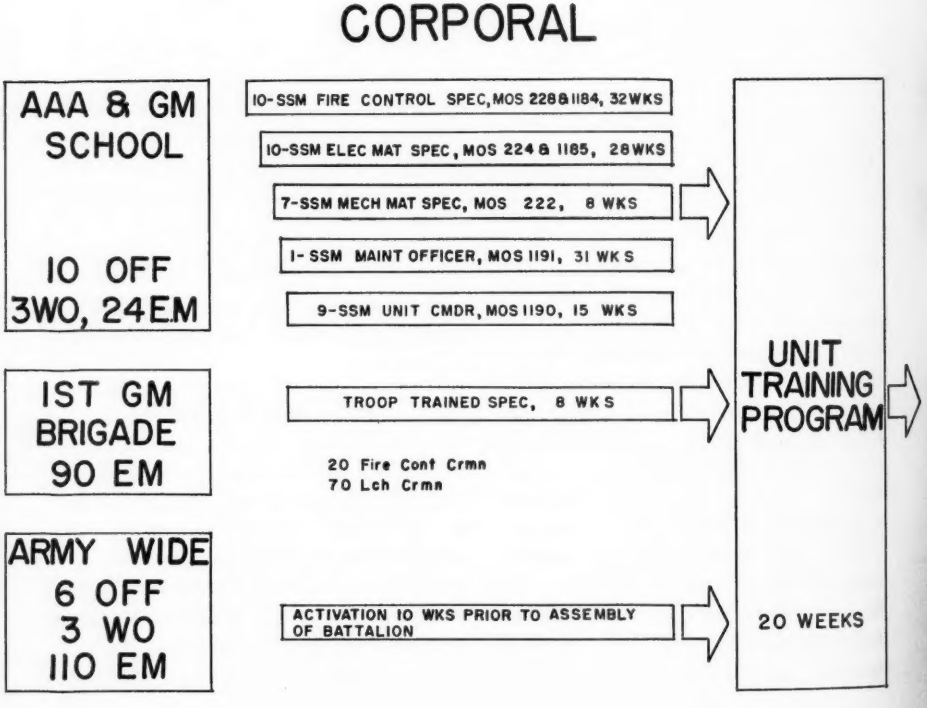
There is great need for trained officers in guided missiles. Detailed information on courses is obtainable from the Secretary, AAA and Guided Missile School.

THE PRESENT AND FUTURE

NIKE I is only the first of a family of surface-to-air missiles. Nike B will shortly be with us.

Corporal is the first surface-to-surface guided missile adapted to tactical use; others under development include the Redstone. The direction in which we go is relatively clear; the time is less precise.

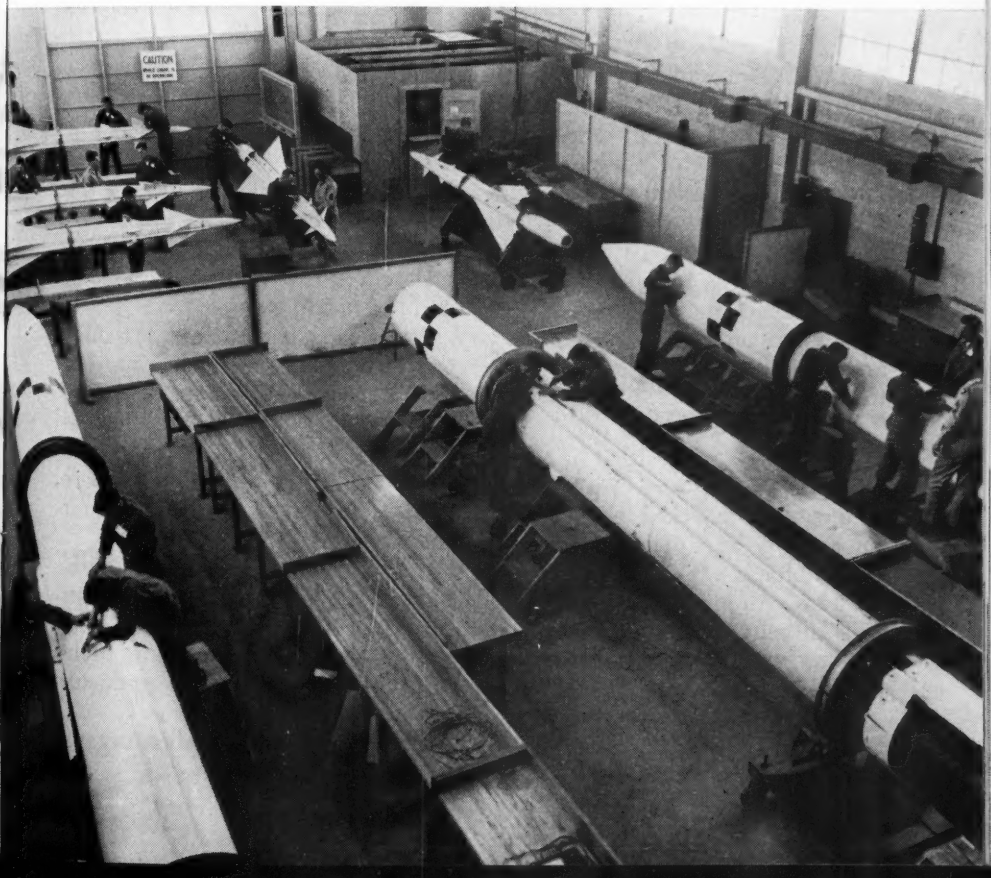
It appears reasonable, however, to assume that the opportunities for both officers and enlisted men


CORPORAL
AAA & GM SCHOOL
10 OFF
3WO, 24EM
IST GM BRIGADE
90 EM
ARMY WIDE
6 OFF
3 WO
110 EM
10-SSM FIRE CONTROL SPEC, MOS 228&1184, 32WKS
10-SSM ELEC MAT SPEC, MOS 224 & 1185, 28WKS
7-SSM MECH MAT SPEC, MOS 222, 8 WKS
1-SSM MAINT OFFICER, MOS 1191, 31 WKS
9-SSM UNIT CMDR, MOS 1190, 15 WKS
TROOP TRAINED SPEC, 8 WKS
20 Fire Cont Crmn
70 Lch Crmn
ACTIVATION 10 WKS PRIOR TO ASSEMBLY OF BATTALION
UNIT TRAINING PROGRAM
20 WEEKS

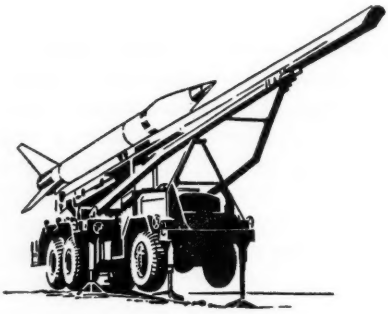
who have guided missile training are almost unlimited. Through participation in the guided missile field, the average soldier becomes a highly skilled specialist performing one of the most important jobs in today's modern Army. He is equipped with knowledge and training which makes promotion to Warrant Officer a realizable goal. When he retires he will find his technical training in demand by an industry ready and willing to pay highly for his services.

IT WAS on 17 April 1775 that a lantern in Boston's Old North Church signalled Paul Revere to start his famous ride. Since that era, both signals and communications have made tremendous progress. But even today, the Minute Men of Lexington and Concord have their modern counterparts in the men who man our guided missiles. Our surface-to-air battalions stand ready 24 hours a day to defend our Nation against any aggressor. Our surface-to-surface missilemen overseas are prepared to add the awesome and destructive power of their deadly weapon to the traditional power of the artillery.

In Laboratory. *Students get first hand experience on Nike and Corporal missiles by handling actual weapons.*



Destruction with a comet's tail is controlled by these men undergoing



Honest John Training

Brigadier General Paul A. Gavan

IMAGINE yourself in a grandstand seat for a 762-mm. rocket (Honest John) firing demonstration. The instructor points out the direction of an assembly area more than a mile away and a prepared firing position immediately to your front. After his initial orientation, he announces that a firing element is now moving out of the assembly area. Minutes later vehicles begin to appear.

You notice that the occupation of position resembles that of a 105-mm. howitzer battery. An advance element has checked the position for security and manned a perimeter defense. Vehicles roll into position. An aiming circle appears. The launcher and wind measuring set are laid for direction. Two men perform an electrical check of the rocket. Suddenly the launcher is deserted. You watch the crew, grouped in a firing pit clear of the launcher. One man grips the handle of a blasting machine, makes a quick downward motion and the rocket is gone.

It is less than 30 minutes since the firing element started moving out of the assembly area. Yet here is no ordinary projectile. This is a rocket capable of carrying an atomic warhead to a range of more than 15 miles; this is the Honest John.

What training is required to prepare this unit to accomplish its mission? Are the men who compose it electronic technicians, highly trained specialists and graduates of long missile courses?

Analysis of the battalion organi-

BRIGADIER GENERAL PAUL A. GAVAN is Assistant Commandant, The Artillery and Guided Missile School, Fort Sill, Oklahoma.

zation shows that about two-thirds of its members are assigned to duties in communication, survey, fire direction, administration, supply, mess management, and motor maintenance. Their training is thus practically the same as that in all field artillery battalions. The remaining one-third, however, are rocket crewmen—artillerymen trained primarily on equipment organic only to Honest John units. New Military Occupational Specialties were created expressly for them.

An examination of the weapons system, however, will show that the Honest John is not complicated. It is not a guided missile. There are no radar sets, computers, and related electronic test equipment. School training is not needed by these rocket crewmen, and their initial selection for this unit is not based on aptitude area scores. A security clearance is the only special requirement.

Training of rocket crewmen is conducted in the unit on its own equipment under the supervision of its own officers and noncomissioned officers. A 29-week training cycle is prescribed.

TRAINING starts with the 8-week basic combat instruction required of all men entering the Army without prior military service. Men of the unit must be able to fight as infantry when so required; its members must be combat soldiers first, then specialists on their equipment.

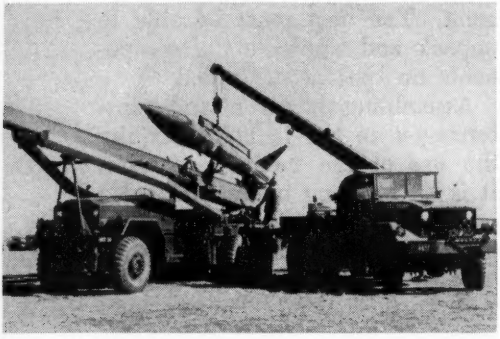
This phase is followed by eight weeks of advanced individual training. At this stage the men begin receiving instruction on the equipment organic to Honest John units. First, there is the rocket, which consists simply of three major components—the warhead section, the body, and the fin kit, each crated separately for shipment. The men must be able to unpack and assemble the components on the rocket trailer.

Assembling the rocket and transferring it to the launcher require the use of the medium wrecker. It is an exacting operation, and a crew requires considerable training to perform it speedily and smoothly.

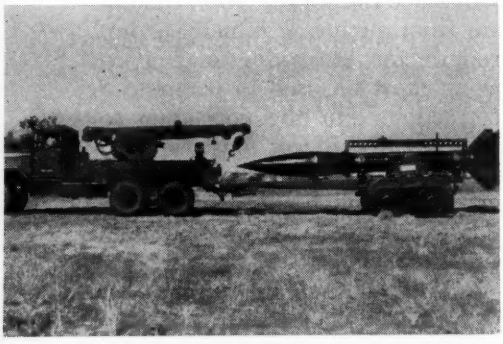
It is characteristic of the rocket that surface winds have a pronounced effect during the first few seconds of flight. This necessitates the use of another piece of special equipment—the wind measuring set. Since the surface winds fluctuate from minute to minute, a procedure for measuring and averaging must be used to compute a correction. For the correction to be valid, the rocket must be fired immediately upon computation. A mastery of this procedure with the timing involved is achieved only through training and practice.

Additional equipment includes the heating blanket for maintaining proper propellant temperature, the sighting equipment for laying the launcher and wind measuring set, the circuit tester for performing the checkout procedure prior to firing, and the blasting machine for firing

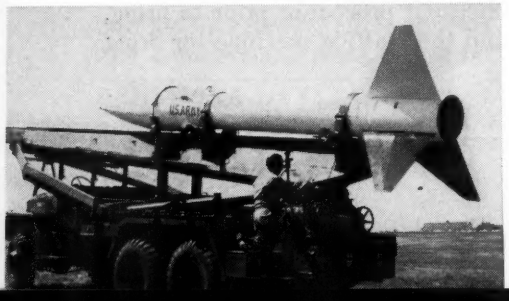
With its components packed in crates, an Honest John rocket is delivered to a firing area . . .



. . . Where it is assembled and hooked to a medium wrecker which tows it off to a launch site . . .



. . . Where a crane (above) lifts it to the launcher (below) and it is elevated into firing position . . .



the rocket. Instruction on all this equipment is conducted in the unit.

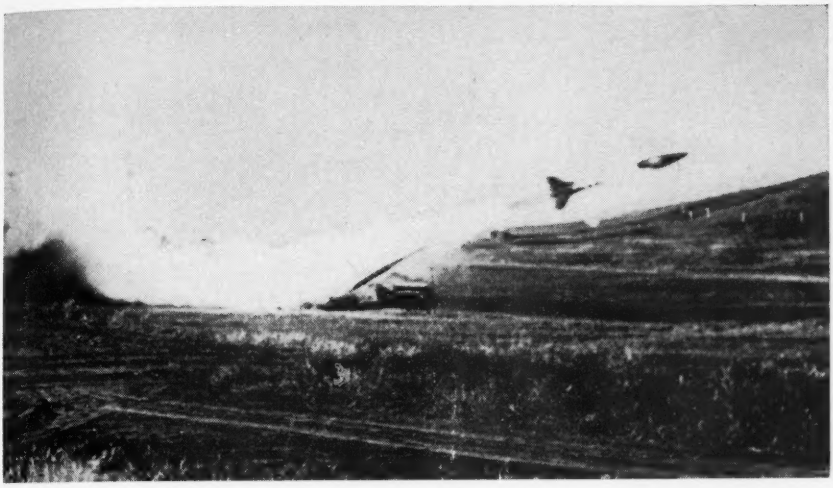
By the time the seven-week phase of basic unit training starts, each section is beginning to work as a team. Teamwork is emphasized and expanded to include the battalion as a unit. The battalion, not the battery, is the basic unit in an Honest John organization.

FIELD exercises and mock firings are conducted. Displacements are practiced, both day and night. Because of its atomic capabilities, the Honest John unit is a priority target for the enemy. It must be concealed. This requires detailed camouflage training, and practice in movements and occupation of primary positions during the hours of darkness.

Each rocket firing is accompanied by a tremendous back blast and dust cloud. In combat, this cloud may indicate to an alert enemy the location of the unit. Firing elements must therefore be capable of displacing immediately after a rocket firing. Execution of such fire missions from alternate positions, followed by immediate displacement is known as the "Shoot and Scoot" technique.

The unit conducts more firings in the final six-week phase of advanced unit training. The men know their job; now it is a matter of speeding up procedures. Combined arms training lasts for two weeks. It demonstrates positively and clearly why Honest John must be delivered exactly on time.

IN THE final week of the training cycle, the unit undergoes the Army training test. Besides evaluating the effectiveness of the unit, as



. . . And within a matter of minutes the rocket is on its way to deliver a power-packed destructive blow.

such, it also measures the effectiveness of the unit's training program. The greatest obstacles to training encountered thus far have been the restrictions placed on firings by limitations on range facilities and rocket availability. Few artillery ranges are large enough to accommodate Honest John firings without severe restrictions. The rockets are too expensive for large ammunition allowances. All personnel must therefore obtain maximum training benefits from each rocket fired.

In the Honest John battalion, the Army today has a combat unit with rugged, mobile equipment and atomic capabilities filling its role as a field artillery unit. It is a new unit, but in one respect it is identical with the old. It will be only as effective as its training permits.

QUALIFICATIONS for enlistment or reenlistment for assignment to guided missile units of the Army Antiaircraft Command (ARAACOM) are spelled out in Army Regulations 601–238. Under these regulations, men with or without prior service may enlist or reenlist in the Regular Army within continental United States for assignment to ARAACOM without regard to monthly quotas.

Enlistment and reenlistment of men in overseas commands is restricted to those who enlist or reenlist from within the service, and is further restricted to those who have completed five-sixths of the normal foreign service tour. Applicants in all cases must be citizens and fully qualified for enlistment or reenlistment as outlined in section II, AR 601–210, except that enlistment will be restricted to those who attain a percentile score of 31 or higher on AFQT.

US ARMY REDSTONE

Training maintenance men as well as cadre at the development site is the unique activity of this School which provides

Ordnance Training in the Guided Missile Field

Colonel H. S. Newhall

LATEST addition to the Army guided missile family is the Redstone. Officers and enlisted personnel are being prepared today for Redstone's early debut in the field. Training in both operation (emplacement, launching and guidance) and logistics (supply and maintenance) of the Redstone is being given by the Ordnance Guided Missile School under supervision of the Army Ballistic Missile Agency at Redstone Arsenal, Huntsville, Alabama.

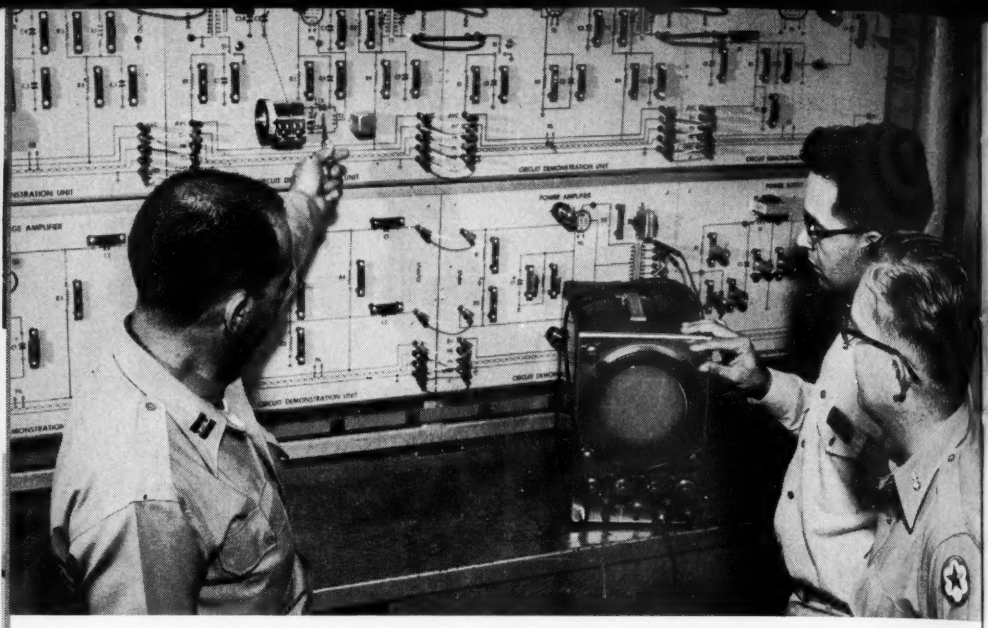
The primary mission of the Ordnance Guided Missile School is to conduct courses of instruction on the logistical support aspects of all guided missile systems developed and accepted by the Army. Ordnance men must be trained to instruct and give technical advice and assistance to the users of the equipment, and to provide maintenance and supply support. With the advent of the Redstone, the School has been called upon to conduct initial training for those who use and maintain the system.

Inclusion of new guided missiles in the Army's arsenal of weapons greatly increases requirements for qualified personnel at all echelons in the stockpile to target sequence. More and greater opportunities are open now for officers and enlisted men of all grades to prepare themselves for exciting and stimulating duty in the operation and maintenance of the newest, probably most significant weapons of the future.

LOOKING AHEAD from its current heavy load of instruction, the Ordnance Guided Missile School is engaged in an expansion program which will greatly increase its capacity and provide facilities of the latest design for accomplishment of its training mission.

Already the School has expanded from its modest beginning less than five years ago to the point where it offers 15 separate courses of instruction. Officer courses are presently undergoing revision to expand the scope of coverage in the guided missile field. A special weapons and guided missile staff officer course, probably of 20 weeks' duration, is proposed to start soon. This would qualify selected field grade officers for duties requiring knowledge of special weapons and guided missiles.

COLONEL H. S. NEWHALL, Ordnance Corps, is Commandant, Ordnance Guided Missile School, Redstone Arsenal, Huntsville, Alabama.



Intricate basic radio circuits are mastered by these student officers receiving instruction in electronics fundamentals.

Under authority granted to the Commanding General of the recently activated Army Ballistic Agency (also located at Redstone Arsenal) the School was given the task assignment in March 1956 to prepare and conduct training for Continental Army Command cadre personnel on the Redstone missile system; to prepare and conduct training for Ordnance maintenance personnel on the Redstone missile system; and to prepare and conduct an orientation course on the Redstone missile system for presentation to key personnel of the Army Ballistic Missile Agency and other associated agencies.

This phase of the School's mission came about because it was mandatory that such training be conducted at the location where research and development was taking place, since the only equipment available for training was that being used in development of the Redstone missile system. As soon as equipment and trained personnel can be made available at an established Continental Army Command school, it is expected that the mission of activation and training of CONARC personnel will be moved to the Artillery and Guided Missile Center at Fort Sill.

Starting in November, Naval personnel also will undergo training in the Redstone-Jupiter missile courses given at the School.

AS HAS been stated, the entire program of guided missile training by the Ordnance Corps is less than five years old. Official entry of the Corps into the field came early in 1951 with establishment of the Guided Missile Division of The Ordnance Training Command, Aberdeen Proving Ground, Maryland.

In March 1952 personnel of this division were transferred to Redstone Arsenal to form the nucleus of the Provisional Redstone Ordnance School. There the first program got underway with seven

officers enrolled in the first Guided Missile Officer Course. During the next four months other courses were added for enlisted personnel and civilians.

The Ordnance Guided Missile School as it now exists was established on 16 February 1953 as a Department of the Army service school and designated a class II activity under jurisdiction of the Chief of Ordnance. To date the School has graduated 5,301 of whom 3,552 are military, 1,666 civilian and 83 Allied personnel.

On 1 February 1956, the Army Ballistic Missile Agency was activated with the assigned responsibility for prosecution of the Redstone missile program and the Intermediate Range Ballistic Missile program. The Commanding General of the Agency has authority to utilize, on a priority basis, other Ordnance installations and activities to the maximum extent practicable, and to accept responsibility for training of units and individuals essential to the prosecution of the assigned programs.

Such an assignment was the important one of training CONARC cadre personnel on the Redstone missile system which was given to the School by the Army Ballistic Missile Agency. This involved assembling the necessary information and documenting the course of instruction. All this would have been impossible had it not been for the fact that the full resources of Redstone Arsenal and the Army Ballistic Missile Agency were available to the Ordnance Guided Missile School.

Much of the information required for proper documentation of the course was not even prepared in writing. This meant that face-to-face conferences were necessary. But because all agencies were located on the same military reser-

Students guide a Redstone missile into exact position on its launcher at Ordnance Guided Missile School.

vation, it was possible to have close daily contact with the engineers and scientists engaged in design and development of the Redstone missile system. Had any of the agencies concerned been located elsewhere, this could not have been accomplished.

THREE levels of training are currently being conducted in the Redstone system. These include:

A one-week orientation course, covering characteristics and functions, given to selected officers, enlisted men, and civilians on a need-to-know basis.

A basic ballistic missile course and specialized individual training, presently limited to personnel of the two existing Redstone units—the 217th Field Artillery Missile Battalion and the 78th Ordnance Detachment (Direct Support) (Redstone).

A unit training cycle for these organizations to follow completion of individual training. This prepares them for operations in the field. At this time it will be necessary to begin individual replacement training to provide for attrition in the two existing Redstone units, and to furnish personnel for additional units which will be activated. As has been stated, such training will continue to be given at the School until equipment and trained personnel will allow establishment of courses by Continental Army Command.

WHILE looking ahead to expanded training programs, the School presently offers 15 separate courses of instruction to Ordnance personnel in the guided missile field. *(See below.)*

Prerequisites are stated in detail in Department of the Army Pam-

COURSES CURRENTLY AVAILABLE AT THE ORDNANCE GUIDED MISSILE SCHOOL

Course Number	*Title*	*Duration*
9–0–21	Ordnance Guided Missile Management Orientation Course	2 weeks
9–0–68	Ordnance Guided Missile Operations Officer Course	10 weeks
9–0–69	Guided Missile Systems Maintenance Supervisor, SAM	43 weeks
9–0–70	Guided Missile Systems Maintenance Supervisor, SSM	43 weeks

FIVE COURSES for enlisted men and civilian technicians in the surface-to-air missile field in launcher control, acquisition radar, track radar, internal guidance, mechanical systems, ranging from 6 to 20 weeks.

FIVE COURSES for enlisted personnel and civilian technicians in the surface-to-surface missile field in doppler systems, computer, radar, internal guidance, and mechanical systems, ranging from 7 to 15 weeks.

ONE COURSE for enlisted personnel and civilian technicians in guided missile propellants and explosives, six weeks.

PREREQUISITES—See D/A Pamphlet 20–21

A Corporal missile placed on its launcher, receives an electrical check by students learning to maintain and fire the weapon.

phlet 20-21. Officers must be in a commissioned status on active duty, with two years or more service remaining after completion of the course, and an actual or anticipated assignment in guided missiles.

Enlisted men entering all courses except the mechanical repairmen courses must be qualified basically as Electronic Repair Helper (MOS 240 or 250). Training in this area is provided in Course 9-E-51, Ordnance Electronics (Entry), at The Signal School. This prerequisite and others are shown in the Army School Catalog, D/A Pamphlet 20-21. Those entering mechanical courses must be high school graduates or equivalent, must have credit for courses in algebra and trigonometry and must have some background in general science.

The two Guided Missile Supervisor Courses, in addition to training warrant officers, offer enlisted personnel an opportunity to be-

come warrant officers upon successful completion of the course, if otherwise qualified. To enter one of these courses an enlisted man must be qualified in an electronic guided missile repair MOS and have six months' experience in the maintenance of guided missile equipment in the field.

TO ILLUSTRATE the opportunities for enlisted personnel in the new field of missiles, let us assume that a corporal desires to specialize in guided missile maintenance. He would make application through channels for a school quota, listing his qualifications, and requesting a waiver if he lacks any prerequisites.

If he desires to become qualified in an electronic guided missile repair MOS, he would request a quota for the 9-E-51 course at Fort Monmouth, New Jersey, in addition to the quota for the desired course at the Ordnance Guided Missile School. At Fort Monmouth he would receive 11 weeks training in basic electronics which would qualify him as a guided missile electronic helper.

Upon successfully completing this course, he would be sent to the Ordnance Guided Missile School for one of the courses in guided missile repair, which range from 6 to 20 weeks.

Upon successful completion of the course, he would be assigned to a TOE unit in the field, or to the Ordnance Guided Missile School, Redstone Arsenal, the Army Ballistic Missile Agency, White Sands Proving Ground, or some other installation or activity requiring missile repairmen. Or he might go to a newly activated Ordnance guided missile support unit at the School.

After six months in the field, he could request a quota for one of the Guided Missile Maintenance Supervisor Courses, with the aim of becoming a warrant officer. Once assigned, he would be placed on permanent change of station to the School for a period of 43 weeks. After approximately 20 weeks in school, he could apply for appointment as warrant officer junior grade, in accordance with Department of the Army Circular 601-17, 14 March 1956. If approved he would be given a warrant at approximately the time he graduated.

INSTRUCTION at the Ordnance Guided Missile School is conducted by military personnel, both officer and enlisted; Civil Service; and contractor personnel. Military instructors—usually trained in one or more courses at the School—are used whenever possible. Civil Service instructors may not have been school trained but must qualify from a technical standpoint.

Since neither military nor Civil Service instructors are available in adequate numbers, contractor personnel from large, well-established companies engaged in missile or electronic work are used in many cases.

Regardless of source, all instructors are well qualified in their fields. Study under them in any of the courses means that the alert, interested student will be well trained and ready for early entry and participation in the far-reaching developments expected in the field within the next few years.

MISSILE CAREERS

Chief Warrant Officer C. E. Driskill, Jr.

This article tells the story of one man who gained success and satisfaction through participation in the Army's guided missile program. His experiences and feelings—typical of those of many other young men who have entered this new field—illustrate in immediate, personal terms the many advantages this field has to offer to enterprising, career-minded men in the Army today.—*Editor.*

AT 0430 the large poster on the battery bulletin board was barely visible by the faint morning light. I looked at it with half-opened eyes as I hurried resignedly toward the mess hall for a day of K.P. "BECOME A PART OF OUR COUNTRY'S FUTURE—SIGN UP FOR GUIDED MISSILE TRAINING," it read, or something like that. I was almost late; and anyhow, who can read intelligently at that hour? But somehow the words stuck in my mind, even while I tried to concentrate on other things.

A picture of a swift and deadly missile formed in my mind. It was awesome and fascinating. It prompted me to investigate the

CHIEF WARRANT OFFICER C. E. DRISKILL, JR., is an instructor in the Guided Missile Department, Antiaircraft and Guided Missile School, Fort Bliss, Texas.

matter of guided missiles further; I *had* to know more! I read all the pamphlets I could find in the battery day room and leaned back in my chair to mull them over.

"Push-button warfare," "speeds faster than sound," "America's best weapons to thwart atomic disaster" —all these were being studied by civilians and the military alike in preparation for the future.

"The future" . . . that's what I was interested in, and guided missiles had already become an inevitable part of it. This looked like my chance to get in on something big, something important, something that would insure my future, too.

It was then the Spring of 1953. I was taking basic training at Fort Jackson, South Carolina, learning to manipulate the M-1 rifle and the heavier weapons used by the Infantry. My mind was made up. I was going to give this guided missile business a try. At least, I probably wouldn't have to lug a missile around on my back!

At the first opportunity I went to see my personnel sergeant who showed me the prerequisites for guided missile training. We talked for a while, and my interest mounted every minute. I liked what I heard, and I applied on the spot for one of the missile courses being given at the Antiaircraft and Guided Missile Center at Fort Bliss, Texas.

TO BE quite truthful, my initial success in the venture rather surprised me, because after all I wasn't familiar with electronics of any sort, and goodness knows I had no conception of how a radar set worked. But I liked the prospect of going to the Army's center for guided missile training and to the fabulous Southwest. The thought of being located at the ranges where all of the Army's guided missiles are fired appealed to me; beside, I was going to find out *all* about one of the newest of the Army's new weapons—the Nike I system.

In a few weeks my application was processed; orders were cut; and I packed my gear and left for the wide open spaces.

On 6 June 1953, I, Private Driskill, arrived at Fort Bliss eager and wide-eyed. Fort Bliss turned out to be a pretty interesting-looking place with impressive security areas, complicated radar sets, and deadly missiles set up for training students like me. Knowing nothing about any of those contraptions, I felt mighty stupid and a little worried. That feeling soon gave way to one of determination; after all, lots of others like me had passed the course I was going to take; and if they could do it, so could I.

MY SCHOOLING started with a sixteen-week course in basic electronics. I learned about vacuum tubes, capacitors, oscillators, and even how a radio works. The instruction was good, and I learned fast. I didn't feel so stupid any more either, because I (of all people) received one of the highest grades in the class!

From basic electronics my class advanced to a study of the acquisition radar used with both the M-33 gun-laying system and the Nike I guided missile system. It was all a new sort of world for me. There I was in the midst of schematic

circuit drawings, magnetron transmitters, and servo systems, and believe it or not, I really learned what made them tick. They weren't half as complicated as I'd first imagined. I guess the thorough step-by-step, learn-a-little-at-a-time training the Army gave me was paying off. My self-confidence increased one hundred percent. I was getting where I wanted to go—fast.

Then almost before I knew it, that long-awaited day arrived—the day my class and I got a first-hand look at the Nike missile itself, its three high-powered radar systems, and its electronic computer. This is what we had come to study, and we were eager to be about it! After all, not many people could get the chance we had just for the asking.

The work went smoothly, and all the bits of information I had learned fitted together like pieces of a jig-saw puzzle. This Nike I system was amazing, but even more so was the fact that I knew how it worked; I could detect troubles that happened and fix them, too!

It was April 1954 when I graduated. It had been a long reach to the first rung of the ladder, but I'd made it with room to spare. Yet just forty-two weeks before, I hadn't even known what a guided missile looked like!

MY FIRST assignment was to the Guided Missiles Department of the School as an instructor on the Nike I computer. The first few weeks I was a bit worried about having to stand up in front of a fifty-man class and spout electronics for four hours, but my apprehension soon vanished. It was stimulating to work with the congenial, intelligent officers and enlisted men in my section. The realization of the importance of my place in the training of men who would man the missiles so essential in our country's defense made me feel soberly proud.

My second big chance happened along in September 1954. The Army had made it possible for PFC's and corporals who were well qualified in the guided missile field to apply for the grade of warrant officer. I put in my application immediately. Just three months later, on 29 December 1954, I put on my shiny new bars and took a look in the mirror at Warrant Officer Driskill! I was walking on air and feeling flabbergasted at the same time. I'd never dreamed of being able to get ahead so fast. Going from Private to W.O. in only two years was really a record!

I was retained in the Guided Missiles Department of the AAA and GM School, but now my MOS was 1184. I tackled my job with new vigor. Who wouldn't?—That extra $150 in the bank each month in addition to having K.P. and guard duty relegated to the past is enough to make anybody a lot happier! The added responsibilities settled me down quite a bit, but I didn't mind working harder. After the chances I'd been given, I figured the Army had a lot of confidence in me, and I was going to do my best to justify it.

I CERTAINLY got in on the ground floor in guided missiles, and it's been a pleasure to be a part of the growth and advancement in that field. Our department at the Antiaircraft Artillery and Guided Missile School has more than doubled its size in the

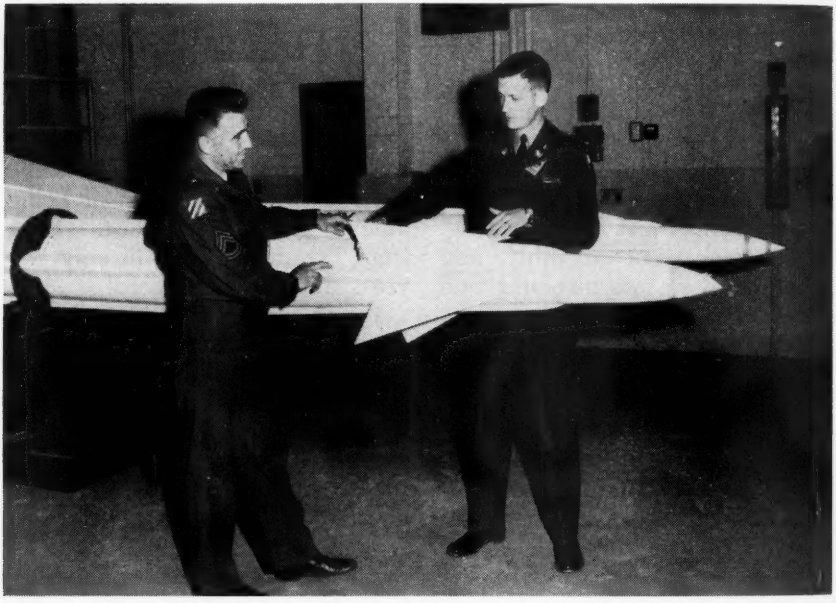
two-and-a-half years I've been assigned here. I can see now that this is the field of the future, just like the poster said that early morning back in 1953.

This work has never been dull. I've learned something new almost every day, and I've been able to keep abreast of each new development that came along. Now I'm attending a preliminary course at White Sands Proving Ground on a more versatile member of the Nike family which the Army is preparing for the future. That means that for the next few years I'll be right up with the missile pioneers, studying the latest equipment and techniques.

To top off this "guided missile success story," I was promoted to Chief Warrant Officer (W-2) in June 1956. That put me in a pay grade roughly equivalent to that of a 1st Lieutenant. The road is wide open on up to CWO-4 which carries with it practically as much pay as that of a major. Where else in the Army could one get a deal like that?

THERE ARE other advantages, too. Tours of duty in guided missiles are fairly stable; I haven't had to move even once thus far. As a result my family and I have thoroughly enjoyed life in the Army. We've been able to make many lasting friendships that probably wouldn't have been possible if we'd had to pull up roots or cavort off to a different end of the country every year so so.

When my tour of duty at the Center is completed, I'm looking forward to assignment on a Nike site. The practical experience to be gained on-site will be invaluable



The author, right, examines a Nike missile with an operations sergeant at the AA & GM Branch of The Artillery School, Fort Bliss.

in broadening my knowledge of the workings of a guided missile system. Many emplacements have been set up all over the country near pleasant communities both large and small. Army housing is now being procured near those site areas which will make life more pleasant for those of us who will be stationed there. Then, too, I'll never have to worry about getting a good job in civilian life after my Army days are over. I've already been offered several good positions without even applying for one. Certainly there's no scarcity of possibilities.

My tale of success in Army missiles is not the only one of its kind; it happens almost every day. Let's face it: This field is the best the Army has to offer. I dare say it can't be topped anywhere else in any service.

Through the ages men have earnestly sought for the respect of their fellows, for a place unique and important in their communities, and for a way to continually increase their knowledge of fascinating things. Modern Americans are no exception. The intriguing and ever-broadening field of guided missiles offers all these possibilities formerly out of reach for many of us. The Army guided missiles program gave me the big chance I was looking for; I took it and worked hard. Now I'm proud of the important place I have on the Army Team, and I'm confident that my future is secure.

"The Nation is in a period of a change in its armament that has been brought about by the development in guided missiles. Guided missiles are beginning to replace many types of weapons that were used in World War II, and this replacement will go steadily forward. In certain cases the developments are not quite far enough along to abandon older type weapons, so for a period it is necessary to keep an operational capability with older type weapons while our capability for use of newer type weapons is being developed."

E. V. Murphree, Special Assistant to the Secretary of Defense for Guided Missiles, in an address before American Chemical Society, 18 September 1956.

TECHNICAL SERVICE TRAINING COURSES

AVAILABLE IN GUIDED MISSILE FIELD

CORPS OF ENGINEERS

GUIDED MISSILE INSTALLATION ELECTRICAL EQUIPMENT REPAIR COURSE. (5-E-63). The Engineer School, Fort Belvoir, Virginia. A 12-week course to qualify enlisted men for Guided Missile Installation Electrician (MOS 357.1).

Purpose: To train enlisted personnel to install, operate and perform organizational and limited field maintenance on high output generators, motors, frequency convertors, power distribution systems, elevator control systems, air conditioning systems, air compressors and other Engineer equipment at Nike installations.

Prerequisites: Minimum of 12 months active duty remaining on completion of course; high school graduate or equivalent with credit for one semester of algebra; standard score of 100 or higher in aptitude area EL.

LIQUID OXYGEN GENERATION COURSE. ( ) The Engineer School, Fort Belvoir, Virginia. An 8-week course to qualify enlisted men for Gas Generating Specialist (MOS 527.10).

Purpose: To train enlisted personnel to operate and perform operator maintenance of equipment used in generation, storage, handling and transfer of liquid oxygen.

Prerequisites: Minimum of 18 months service remaining after completion of course; credit for high school chemistry and algebra or a standard score of 50 or higher on GED tests 3 and 5 (high school level); standard score of 100 or higher in aptitude area GM.

ORDNANCE CORPS

ORDNANCE ELECTRONICS (ENTRY) COURSE. (9-E-51). The Signal School, Fort Monmouth, New Jersey. An 11-week course to train enlisted personnel as Fire Control Repair Helper (MOS 230.0); Surface-to-Surface Missile Electronics Repair Helper (MOS 240.0) or Surface-to-Air Missile Electronics Repair Helper (MOS 250.0).

Purpose: To train enlisted personnel to assist in repair and depot maintenance of Integrated Fire Control and guided missile equipment; consists of instruction in electrical fundamentals; electronics as applied to basic receivers and transmitters; nonsinusoidal circuitry; supply catalogs and procedures.

Prerequisites: A standard score of 100 or higher in Aptitude area EL; high school education or equivalent as determined by appropriate GED tests; security clearance to include SECRET. Quotas are allocated by The Adjutant General.

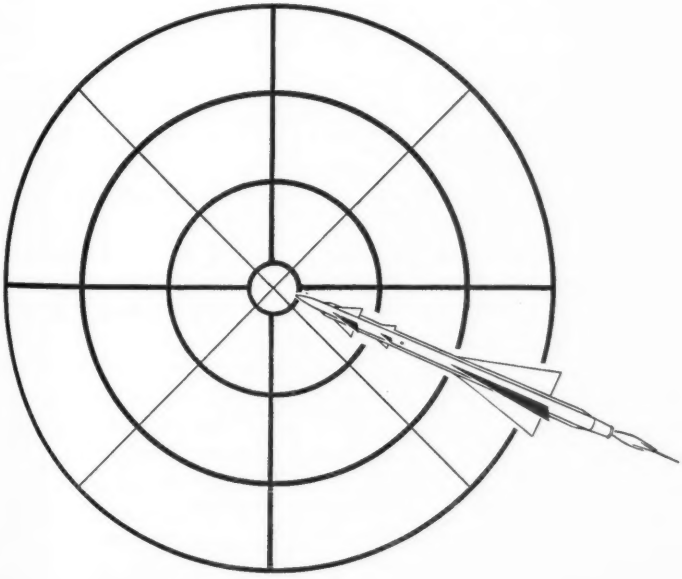
TRANSPORTATION CORPS

TRAINING in Transportation Corps aspects of Army missiles is given in various courses at the Transportation School, Fort Eustis, Virginia. In the Transportation Officer Advanced Course of 35 weeks, formal courses are given in special weapons orientation and surface-to-air missiles.

In the Associate Transportation Officer Advanced Course of 16 weeks, instruction is given in atomic warfare, including delivery means; while similar training also is given in the Transportation Company Officer Course.

IV. The Commands

"Army units must be organized for combat, and equipped, to provide improved air defense, increased mobility, and fire support of greater range and effectiveness."



Already a predominant weapon in the Army's antiaircraft defense of continental United States

MISSILES GUARD THE VITAL C

Lieutenant GeneraS. R. M

THE first six years of the Army Antiaircraft Command (ARAACOM) have been incredible years—incredible, that is, by comparison with other historical periods of military development. For in that short period of time, this major command of the Army has been authorized, organized, trained, put in position and equipped with fantastic new weapons. Moreover, all this has been accomplished with a forward look to maximum acceptability for years into the future.

Not only has the Command brought the United States Army to the front porch of millions of Americans, but it has, at the same time, brought the Army's remarkable progress in the missile field directly to the Nation's attention.

From its very inception, ARAACOM has been a dynamic organization. Formed in July 1950, five days after the North Korean invasion, its responsibility rapidly shifted from the early planning and development of units to full command of Army units assigned to provide the antiaircraft defense of the Nation. In 1954, ARAACOM became the Army member of the tri-service Continental Air Defense Command, which was created at that time to formalize existing defensive arrangements.

ARAACOM is a major Army command directly under the Chief of Staff, United States Army. Administrative and logistical support is furnished to ARAACOM units by the six continental Armies.

Nation-wide the command is broken down into five regions, extending to all corners of the United States. Brigades, groups, battalions, and batteries complete the command structure.

THE United States, with its ten thousand miles of border surrounding three million square miles, requires a big team to guard it. And, although stress is placed upon guarding the Nation's cities and industrial centers, it is also true

LIEUTENANT GENERAL S. R. MICKELSEN is Commanding General, Army Antiaircraft Command, Colorado Springs, Colorado.

AL CENTERS

Gener[illegible]. R. Mickelsen

that there are just not enough defense dollars to provide guns, missiles, and men to go all around.

An increasingly important contribution is being made by National Guard antiaircraft units. As Regular Army gun units are converted to guided missiles, various states are assuming the manning of the gun battalion equipment. Instructor-maintenance teams are left on site by the Army for periods up to three months to assist Guard personnel in taking over the responsibility. ARAACOM gun battalions consist of 120-mm., 90-mm., and 75-mm. Skysweeper units. For some time to come these tried and true elements of air defense will continue to play important roles in augmenting the protection provided by the Nike guided missile battalions. But already the Nike guided missile battalions predominate, outnumbering the conventional gun battalions.

PROXIMITY of these units to population and industrial centers has contributed to increased awareness of the Army by the local citizenry. Often, the local businessman, the home-owner, and the city official, through neighborhood contact with members of the local antiaircraft artillery unit, discover for the first time what the present-day American soldier is like; they learn, too, how the Army operates; and they can see, poised in readiness, the weapons that the Army employs to defend their homes and the Nation.

With "Nike" now a household word, the average citizen is no longer a stranger to the weapons forged in his interests. He begins to appreciate and recognize the necessity for spending his hard-earned tax dollars for installations such as these.

This familiarity with Nike has proved to be an excellent thing for the Nation. Provided with first-hand information about their defensive weapons, the American people have been in a far better position to decide upon the merits of the program they support. This is a program they understand and

Always at the ready, Nike installations, like this one on the West Coast, guard scores of vital areas through the country today.

appreciate—an activity that is real, in being, ready and capable to defend their home communities. This means much to the practical minded American.

THOUSANDS of manhours of hard thinking, planning and productive effort have gone into the perfection of the Nike guided missile system. Not only has it surpassed the original planning requirement but it has provided a system which will accommodate the "future" weapons that may be developed. This is perhaps the outstanding accomplishment of the past six years. Without this emphasis on future acceptability, millions of dollars and years of defense would have been jeopardized. With it, the Army has not only provided the Nation with an active defense today, but also has provided the basis for defense into the foreseeable future.

Some of the early decisions of long-range import included—the adoption of rocket design for Army missiles; the firing system that provided controlled disposal of the booster; the command guidance system; and the emplacement of firing units where the enemy must come. These are but four examples of the decisions that had to be made before Nike was even out of the drawing board stage.

How effective would our antiaircraft defense be today if it were dependent upon winged missiles instead of the rocket type? Because of the forethought in the design, the Army's artillery missiles can outmaneuver any winged craft; can outspeed any winged craft; can destroy any winged craft. The reverse is not true. Nor is there any assurance that any winged missile may even overtake another winged craft, either in speed or maneuverability. Yet winged missiles were popular in the early days of study. Think what the situation might be today if the rocket-type design had not been adopted.

Consider also the safely disposed booster. How would the residents of our cities rate Army wisdom if they were told that the missile booster might fall any place in a 360 degree circle around the bat-

tery site? Even with the knowledge that the Nike system provides safe disposal of the booster by dropping it always in the same cleared area, there were many that opposed site locations on this score. The Nike system provides safe booster disposal for any future developments of missiles and ways are being sought to provide frangible boosters.

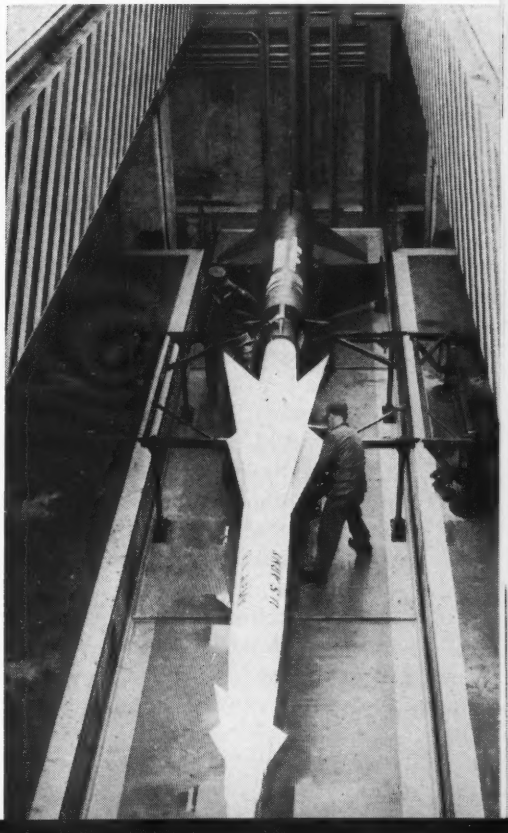
GREAT CREDIT accrues to early planners, too, for the adoption of the command guidance system for controlling the missile in flight. The adoption and development of this system assures that the missile will not wander off on some independent tangent, will not "home" on something other than the target, and will not miss because of some evasive tactic of the enemy. The command guidance system is a method by which the commander on the ground can control a missile throughout its flight. For decades, artillerymen have desperately wished that new guidance instructions could be given a projectile in flight. Now, with the Nike system, it can be done.

Another vastly important basic step was the establishment of antiaircraft units "on the target." In no other way could the number of available missile units be utilized to the maximum. Essential though the searching of wide horizons must be, it is axiomatic that the search for the enemy narrows and is easier as he approaches the target he seeks. And, as the area narrows, maximum pressure can be applied upon the enemy.

ARMY antiaircraft units are now disposed around the Nation, to the extent that funds provide, in locations to which an enemy must come if he is to attempt to destroy critical target areas. Here the units can deliver the maximum effective fire on an enemy regardless of the direction from which he approaches. And the units of such defense provide mutually supporting fire.

A guided missile unit may not be the most desirable occupant of a public park, or beach, or residential plot—desirable, that is, from the point of view of the zoning authorities. But the undesirable aspects are infinitesimal when com-

In an underground storage pit, missilemen move a Nike to an elevator platform for lifting to the launching racks.

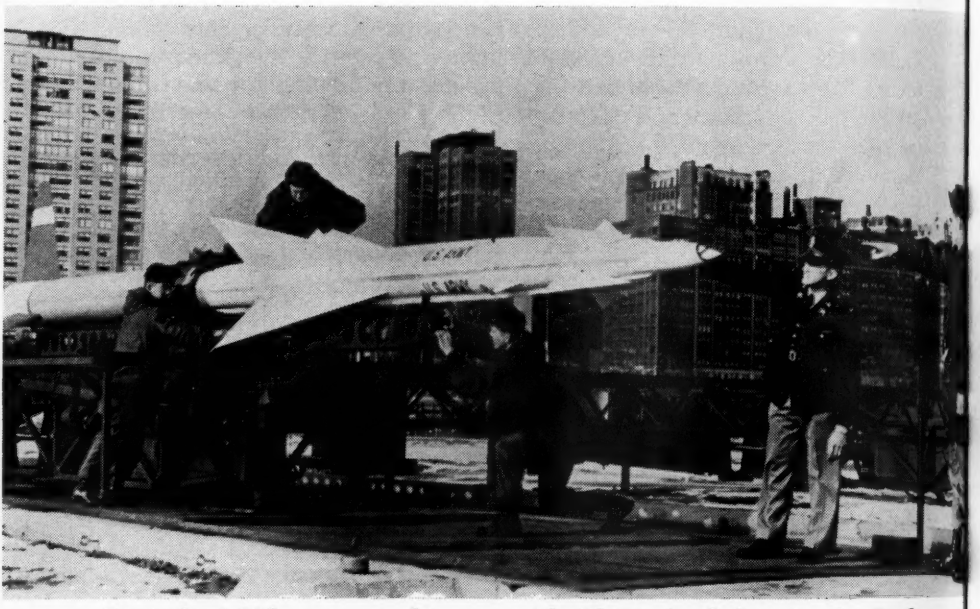


pared with the prospects for ultimate survival.

Faced with the necessity to conserve in military expenditures and the need to provide the most economical of defenses, we cannot afford to be strong everywhere. Strength must be concentrated at the vital points. This principle of economy is now used in locating Nike units and will be used in future expansion as funds are made available.

take. This esprit is reflected in the relations which individuals and units now enjoy in the communities they guard.

INITIALLY the antiaircraft units met with some resistance at the local level, as sites were established at points from which the best defense could be effected. These early misunderstandings have almost universally been replaced by the most cordial of relationships,



Typical of Nike sites is this one with Chicago's skyline in the background. The crew runs through its daily readiness rehearsal.

It is not surprising, therefore, that ARAACOM members show pride in their assignments. Fully aware of the vital role they must play, they recognize that it is a combination of their personal skill, devotion to duty, and the weapons at their command that permits the timely destruction of any attacking plane regardless of the height, speed, or evasive action it may

based upon mutual confidence, respect and a recognition of the needs of national security.

What were initially *problems in* public relations were transformed into *opportunities for* public relations. Positive, constructive actions designed to let the next door neighbors know his local AAA unit better, to realize just what these weapons could and would not do,

led to warm acceptance and full support.

This public support and confidence in the ARAACOM unit is a prime essential. More than any other factor, it contributes to that feeling of belonging, of being relied upon, that engenders the esprit of the ARAACOM man on the job for the long hours, the seven-days-a-week grind that is required.

Gradually, too, the Army is obtaining funds to meet housing needs for the crews and their families; it is looking after their recreational needs in off-duty time; and it is contributing in a variety of ways to the development of welfare and a high morale.

Each soldier on the job at every ARAACOM defensive site must be alert to his responsibilities every minute, off duty or on. For, regardless of how perfect or how "aware" a machine may become, it will always require activation, motivation, and control by man if it is to be selective in its tasks.

IN ITS essential elements, air defense operations consist of long range detection, identification, interception, and destruction. The Air Force is primarily responsible for long range detection and identification of aircraft, although both the Army and the Navy have inherent capabilities in these fields.

The Army antiaircraft role is cryptically phrased in the slogan, "Ack-Track-Smack." The ARAACOM unit "acquires" a target on its radar either by its own initiative or it is passed on from other sources; it "tracks" the target by radar until it is ready to shoot; and then it destroys it by gunfire or guided missiles. *(See page 62.)*

The Army is continually improving its capabilities in this field, as in others. The Missile Master is one such development which answers the vital need for definite, selective coordination of a defense's missile units in an engagement with many enemy planes attacking simultaneously.

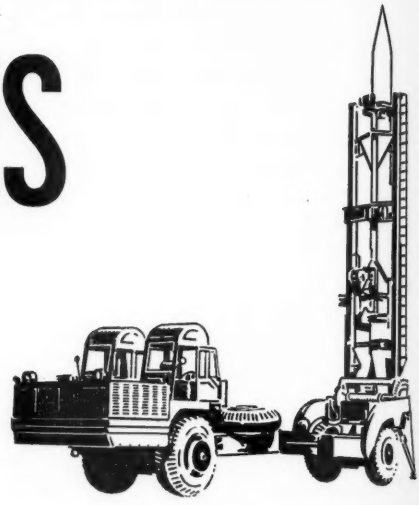
A virtual electronic wizard perfected by Army and industrial scientists and craftsmen, the Missile Master in effect provides a large number of Nike firing batteries not only with a complete picture of all friendly and enemy planes in the area, identifying each carefully, but also shows each battery what targets are being engaged by other batteries. On the basis of information presented by this device, the battery commander may make the best decisions on the engagement of targets, so that none may escape.

When such extraordinary capabilities as provided by the Missile Master are combined with the increasing capabilities of Nike, it is evident that the Army is providing a realistic defense for the Nation—a defense which approaches completeness, and which carries with it an assurance that America shall continue to live and be strong.

To accomplish this realistic defense, regardless of any enemy efforts at attack from the skies, is the real mission of the Army Antiaircraft Command. It is a mission and an organization with which every member of the United States Army should be familiar. For the record of ARAACOM is a story of not just a few people, not just a command, but an outstanding accomplishment of our Army in meeting tomorrow's defense needs today.

Power and range are stepped up by the Army's

FIELD ARTILLERY MISSILES



Major General
Thomas E. de Shazo

AN ARTILLERYMAN crouches beside a 105-mm. howitzer. At a signal, he pulls a lanyard sending 35 pounds of steel and high explosive six or seven miles to stop a five-man enemy patrol.

Compare this action and the results with that of another artilleryman.

The second man listens on an intercom system from his position at a firing panel. The count down comes—"5–4–3–2–1–FIRE." He closes a firing switch, sending a missile-borne warhead, the yield of which is equivalent to thousands of tons of high explosive, to blast an entire regiment assembled deep in enemy territory.

While these contrasting examples are not the extremes of present-day artillery capabilities, they nevertheless help to illustrate the broad requirements imposed on the artillery in order to accomplish its assigned mission.

Recognizing the validity of the old adage that "a bird in the hand is worth two in the bush," field artillerymen today are holding onto their proven weapons systems with one hand while they reach out with the other for new and better means of fulfilling their mission. Throughout the ensuing discussion of new weapons and the organizations and tactics developed for their use, it should not be for-

MAJOR GENERAL THOMAS E. DE SHAZO is Commanding General, The Artillery and Guided Missile Center, Fort Sill, Oklahoma.

gotten that within their range capabilities and effects desired, the cannon artillery still enjoy an advantage in rate of fire, low cost, accuracy for close support, and reliability.

A REVIEW of the artillery's role makes it evident that guided missiles and rockets can materially assist in the accomplishment of the artillery mission. The field artillery supporting the other arms by fire must neutralize or destroy those targets which are most dangerous to the supported arm. In effect the field artillery gives depth to combat and isolates the battlefield, by counterfire, by fire on hostile reserves, by restricting movement in rear areas, and by disrupting hostile command facilities and other installations.

The Army has a requirement for a family of field artillery missiles to provide all-weather direct and general support for land, airborne, and amphibious combat operations. These missiles, carrying appropriate warheads, must reliably and accurately extend beyond cannon artillery coverage; they also must supplement and extend the capabilities of support aircraft. They should provide high accuracy and great destructive effect on "hard" targets, such as tanks and fortifications, and furnish supporting fires of acceptable accuracy for combat troops making deep penetrations, such as airborne assaults or armored breakthroughs.

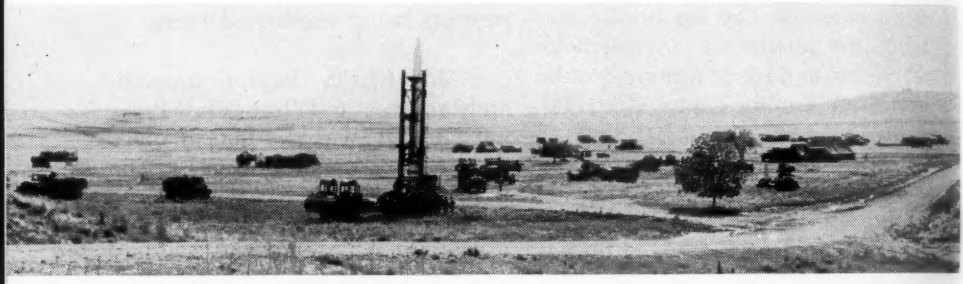
When the artillery arm received initiation into pushbutton warfare in the late forties, equipment was practically nonexistent. A few V-2's plus some other odds and ends had been brought from Germany. A few copies of the V-1, called the Loon, were produced, and some experimentation was being carried on with the Lark—a missile which the Navy had been working on at the end of World War II, hoping it would stop the Japanese *kamikaze* pilots.

Carefully selected officers and enlisted men were sent to civilian schools, factories, and laboratories to receive guided missile training. Upon return, they provided the base for service school courses and training programs; they also furnished assistance to Army Ordnance at White Sands Proving Ground on the various missile projects being conducted there.

FORT BLISS, located immediately adjacent to White Sands Proving Ground, was the logical place to centralize activities. The Department of the Army therefore initially gave the Commanding General of the Antiaircraft Artillery and Guided Missile Branch of the Artillery School the responsibility for the Army's guided missiles.

As the Corporal and Nike guided missiles started to materialize, the job of the artillery grew. Responsibilities for various facets of the program were delegated, following as nearly as possible the existing pattern for other artillery weapons. The Commandant of The Artillery School was given the responsibility for development of training programs, training literature, and tactical doctrine for field artillery missiles. Range requirements and the ever-present shortage of equipment, spare parts and support units necessitated retaining the units and specialist training at Fort Bliss for some time.

Late in 1955 with Corporal and Nike units trained and deployed and the Army's guided missile program steadily broadening, it was determined that the optimum arrangement for the production of well-trained personnel, sound, tested doctrine and techniques, training publications, and policies, for field artillery missile systems would be achieved by concentrating the responsible school, the appropriate CONARC Board, and using units all at one installation. With missile units now stationed at Fort Sill, facilities are being readied for the conduct of specialist and operator training for present and future field artillery missile systems. This decentralization will permit the agencies at Fort Bliss to concentrate their entire effort on antiaircraft defense.



With its crew standing by, a Corporal missile is prepared for firing during a test run.

ADDITION of new field artillery weapons has resulted in a newly conceived organization to handle them. Initially the atomic delivery systems were organized like standard field artillery battalions with a battalion headquarters, headquarters battery, firing batteries and a service battery. In the case of a Corporal battalion this meant an approximate strength of 600 men and officers.

Tests have indicated that this organization is unsatisfactory for units whose primary mission is the delivery of atomic fires. Normally, in order to achieve a decisive volume of fire with nonatomic artillery, several guns are authorized each battery and several batteries authorized each battalion. But the new weapons can deliver the same volume of fire with one missile!

To exploit the potential of three firing batteries in an atomic artillery battalion, the unit would have to be dispersed laterally to cover a large sector. The distances involved in such dispersal would nullify the operational and logistical advantages of centralized battalion control, relegating the battalion headquarters role to little more than that of a radio relay station.

These considerations resulted in the present single fire unit organization which contains a headquarters and service battery and one firing battery.

This type organization, with an aggregate strength of about 250 men, has been adapted to the Redstone, Corporal, and the Honest John rocket units.

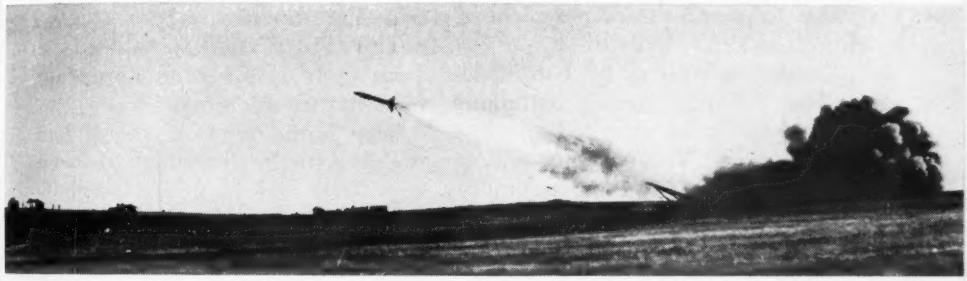
UNIQUE feature of the present organization is that only one mess section is provided for the battalion. All support functions, including ammunition supply, motor maintenance, and personnel administration, have been consolidated. The firing battery is the firing battery portion of a lettered artillery battery.

These units contain the minimum number of personnel necessary to accomplish their primary mission. They have a limited capability for simultaneous defense against ground attack, and no capability for active defense against air attack. The problem of local security, always present, will be increased greatly in such units.

If the force commander is to have atomic support, he must protect the units capable of providing it. An enemy can be expected to use every possible means to counteract atomic weapons, the most effective being to prevent the missiles from being launched. Accordingly he will concentrate his resources, including sabotage, guerrilla action, infiltration, and special striking forces, to weaken our ability to deliver atomic fires. It is therefore incumbent on the employing headquarters to provide ground and/or air defense as required by atomic missile units.

Certain security measures are common to the employment of all missiles and rockets. The units themselves should be given priority consideration in the assignment of areas, and whenever possible their movement should be confined to the hours of darkness or periods of poor visibility. Close attention also should be given to the development and execution of a sound deception plan.

Employment of weapons in pairs is another command action which will increase the assurance of timely atomic artillery fire support. This technique is based on the concept that atomic targets are of sufficient import to warrant buying insurance. This can be achieved either by assigning the mission to two different battalions which can reach the target, or by directing one unit to prepare two missiles or rockets. In either case, the count down is so controlled that a switch to the alternate launcher or unit can be made with a minimum loss of time.



An Honest John rocket picks up speed in a flash as it roars toward a distant target.

WITHIN the pattern of general techniques, the capabilities of spe-

cific weapons must be considered. Although the 762-mm. rocket, commonly called "Honest John," is not a guided missile, its ability to carry a huge payload, including a variety of fragmentation and atomic warheads, to ranges normally used with corps artillery earns it a prominent place in any such discussion.

Honest John units were originally organized as separate batteries; however, they are being reorganized as single-fire-unit battalions. There are two firing platoons of two launchers each, giving the desired flexibility. Sufficient personnel and equipment have been provided to permit the employment of firing sections individually or as platoons, as well as by battalions.

The 762-mm. rocket battalions will normally be attached to corps and division. The basis for allocation corresponds to the capabilities of the weapon.

THE first field artillery guided missile was the Corporal, and the single-fire-unit organization was tested with this weapon.

The unit headquarters and service battery is similar in organization to that of an Honest John battalion. In the firing battery, to support two launchers, there are sections to handle a checkout and assembly of the missile, and a guidance platoon, since Corporal receives commands from the ground. The tremendous scope of enemy territory which is within the capability of the Corporal unit is staggering to anyone accustomed to thinking in terms of light artillery fire. Statistically, it runs into thousands of square miles.

From the tremendous capability of the weapon, it is evident that the Corporal lends itself to being employed at army level, directly controlled by the army artillery commander. Allocation of these battalions gives him direct control of a weapon with which he can influence the battle.

IN deploying Honest John or Corporal battalions, the commander will base his choice of method on an evaluation of the mission, the terrain, and the enemy and friendly situation. Of prime importance are the enemy's relative air strength and the indications of his intent with regard to use of atomic weapons. The principal difference in the deployment of Corporal and Honest John units is the time needed to occupy a position and fire.

The battalion may consolidate within a single area which has been organized and improved to allow the battalion to remain there, as long as it can accomplish its mission. This method has the advantage of minimizing command, administration, mess, local security, and launcher reload problems. Targets of opportunity can be engaged in a minimum length of time, and more complete cover can be prepared for personnel and equipment. There are certain disadvantages, however—namely, the vulnerability of the battalion, and the requirement to displace the entire battalion whenever a firing site is compromised.

A second method of deployment is to separate the firing battery at a distance from the remainder of the battalion. This reduces the size of the target presented to the enemy; and enemy fire directed at the firing positions will not neces-

sarily require displacement of the entire battalion. This method of deployment, however, complicates administration, messing, and other command functions.

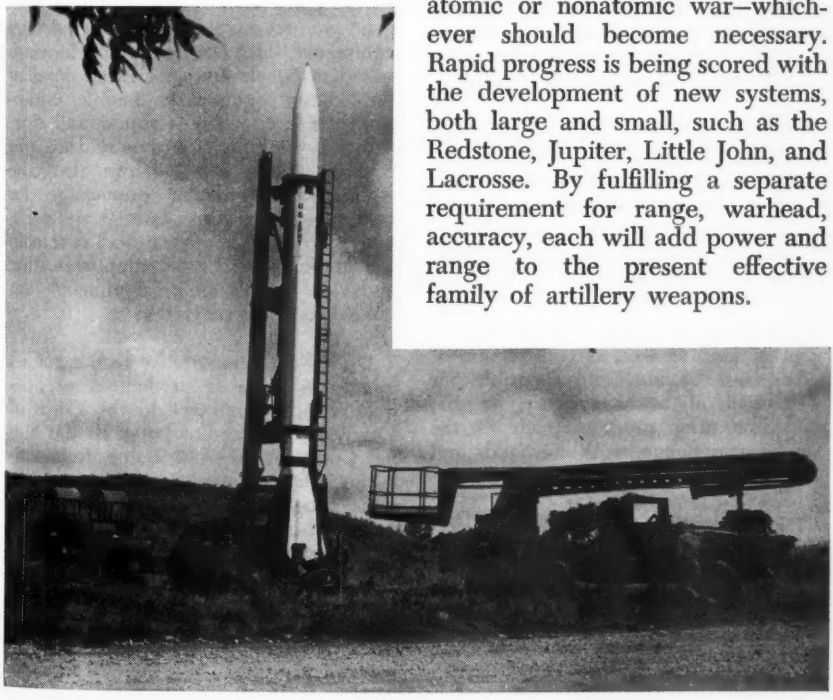
Still a third method involves a variation of the first. The entire battalion is deployed in an area affording excellent natural cover or camouflage. The firing elements are sent to prepared positions to execute a fire mission and immediately after firing return to the battalion area. Firing positions are prepared within the battalion area to permit rapid emergency attack on targets of opportunity.

This method offers most of the benefits of the single battalion position area, since elements of the battalion are separated only for short periods. Moreover, enemy detection of the firing positions does not disclose the location of the remainder of the battalion. Among the disadvantages of this method—displacing elements may be detected and are most vulnerable while on the road; also, requirements of the supported force may preclude displacement.

A fourth variation is to deploy the firing elements in firing positions. After a mission they are displaced to the immediate vicinity of an alternate firing position for reloading, thus being ready to attack targets of opportunity without appreciable loss of time.

IN SUMMARY, it must be emphasized that the artillery must be and is prepared to fight either an atomic or nonatomic war—whichever should become necessary. Rapid progress is being scored with the development of new systems, both large and small, such as the Redstone, Jupiter, Little John, and Lacrosse. By fulfilling a separate requirement for range, warhead, accuracy, each will add power and range to the present effective family of artillery weapons.

Equipment associated with operation of the Corporal is deployed for a firing demonstration at Fort Sill.



ENGINEER CONTRIBUTIONS TO THE MISSILE PROGRAM

FIVE broad areas comprise participation by the Corps of Engineers in support of guided missile and rocket fire. They include provision of engineer troops, construction activities, supply and maintenance of engineer equipment and materiel, development of new engineer materiel, and provision of maps and geodetic data.

The first area includes training of troops for special assignments in the guided missile program. At the Engineer School, Fort Belvoir, Virginia, enlisted personnel are trained as Guided Missile Installation Electricians for subsequent assignment to Nike batteries; training also is provided for officers and enlisted men for Engineer companies that will support Redstone battalions.

HIGH priority has been assigned to providing the "push" that will give the Redstone missile its "punch." In this connection, the Engineer School recently added a new course in the liquid oxygen (LOX) field.

Training also will be provided for essential support in other activities such as surveying, to insure accurate launching site and target positioning, camouflage, fire fighting, decontamination after a CBR attack, construction of facilities.

IN THE field of military construction, the Corps of Engineers provides for the Ordnance Corps the laboratories, testing facilities, administrative space for research and development as well as manufacture of missiles; launcher stations for the Anti-aircraft Command, and facilities for training of troops.

The Corps is charged with procurement of land as well as construction of Nike sites. It also is responsible for acquisition of land necessary for the guided missiles program such as the Alamagordo Range at White Sands and the McGregor Range at Fort Bliss.

IN fulfilling its supply and maintenance functions, the Corps of Engineers program during fiscal year 1957 calls for radically new items of equipment developed specifically for missile support.

Some of these items are 50-ton per day portable knock-down liquid oxygen generating plants, air transportable 5- and 20-ton per day plants, semi-trailer mounted liquid oxygen transportation and storage equipment, rocket propellant neutralizer equipment for safety of operating personnel and special electrical power generating equipment.

DEVELOPMENT of Engineer materiel and techniques essential to operation of various guided missile systems is a vital part of the Corps of Engineers mission. Much of this phase is devoted to meeting the exacting electrical power requirements demanded by the precision electronic equipment used in guided missiles. Currently Engineers are engaged in a continuous development program to produce a family of lightweight, precision-controlled electric power generation equipment.

Because guided missiles require a source of high pressure, moisture and dirt-free air to pressurize their propellant systems, the Corps of Engineers has developed and procured several types of compressors to meet these requirements.

Another highly important program is development of a family of liquid oxygen production handling and storage equipment. Still other programs have resulted in developing specialized types of fire-fighting equipment; mobile equipment for producing, transport and storage of dry ice (solid carbon dioxide) for cooling certain missile-borne electronic equipment; producing camouflage for field use; developing materiel and techniques to combat erosion and dust control problems; and production of heating and air conditioning equipment for guided missile control vans.

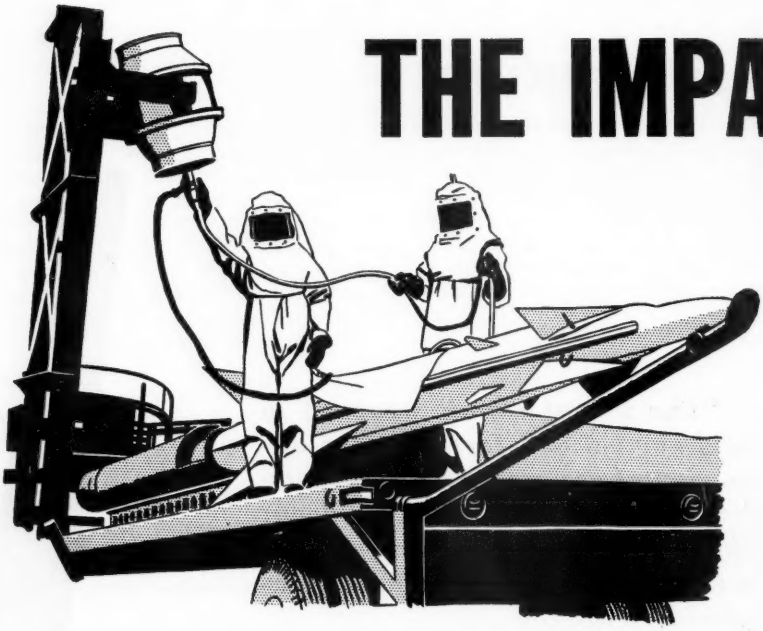
OF GREAT importance in the guided missile program is production of adequate maps. In this field the Corps of Engineers in coordination with the Signal Corps and the Air Force, is investigating methods and techniques to determine geographic location of targets for surface-to-surface missiles in inaccessible areas, and where little or no ground control is available. Extensive use is made of latest scientific methods, including high altitude electronically controlled aerial photography, electronic digital computers and others.

V. The Future

"The use of atomic weapons in land combat will force greater dispersion of ground forces. The combat zone will be wide and deep; clearly defined lines between battle areas and rear areas cannot be expected."

War's principles are unchanged, but its problems are intensified and time scales accelerated by

THE IMPACT OF



MISSILES plus atomics represents a revolution in the military art.

Normally any military innovation means logistic problems. But revolution means problems *in spades.* A scant decade ago, Army language didn't even include terms such as LOX and inertial guidance, and the like. Along with the new words have arisen new skills, new techniques, new hardware, and all their related problems.

Generalizing on missiles as a whole is an attractive intellectual trap. In a discussion of these weapons systems from a realistic logistical viewpoint, we must differentiate between the free rocket of the Honest John type; the guided missiles, such as the surface-to-surface Corporal and the surface-to-air Nike; and the ballistic missiles, Redstone and Jupiter, the latter reaching out to intermediate —as distinguished from inter-continental—ranges.

IT IS a true generalization that all missiles systems are complex. However, the free rocket is probably the least complex. It needs merely to be pointed in the right direction, and goes off with a roar, something like a skyrocket. While it has great advantages in tactical mobility and flexibility, the rocket's

BRIGADIER GENERAL RICHARD D. MEYER is Chief, Plans & Programs Division, Office of the Deputy Chief of Staff for Logistics, Department of the Army.

CTOF MISSILES ON LOGISTICS

Brigadier General Richard D. Meyer

weight is such that it is the same as shooting up a considerable piece of an artillery tube and carriage with each round fired. The weight of the missile highlights the logistic problems of both re-supply and movement of the unit.

Guided missiles have all the problems of the free rocket, but add to their logistic limitations that of electronic complexity. The guidance systems permit the commander to "talk" back and forth with the missile, determining where it is with respect to the target, and telling it how to change its course to score a hit. Since missile times of flight are measured in seconds, the electronics gear is somewhat more complicated than an EE-8 field phone! In the Corporal guidance system, the equipment is mounted in a number of large van trailers. Its maintenance is the unit commander's greatest logistic headache.

In contrast, the ballistic missile guidance system is largely contained in the weapon itself. In fact, most of it is mounted aboard both Redstone and Jupiter. If the free rocket type weapons system may be said to shoot off a "piece" of the gun and carriage with each round, then the ballistic missile must be said in addition to shoot off nearly all its guidance system. From the missile fire unit commander's point of view, his most pressing logistic problem is his liquid fuel supply.

The atomic capability of each of our missiles is one more complication which makes missile logistics considerably different from anything known to date. Governed as the atom is by legal and other restrictions (physical and administrative), the logistics of atomics is an

art apart. Let us put it as beyond the scope of this article, and accept the fact that it is very complex!

THE revolution in military weapons systems now at hand, like the Industrial Revolution of modern history, calls not only for special equipment, skills, techniques, but a new military philosophy. Without the latter, logistical problems can become logistical impossibilities. No logistics, no firepower.

Here are some specifics.

● ***Producibility.***

Missiles are complex. There are few counterpart components in civilian production. This means it takes longer to get production going, and longer time from order to delivery. It means that the Army, as the technical expert, must train industry in the art, rather than relying on a wide civilian know-how. Not only are initial costs a great deal higher than for conventional type weapons, but the industrial facilities must be provided almost from scratch. We can't just add another line in a stove factory, and make missiles. These weapons even require special buildings plus a host of unique single-purpose tools.

● ***Guidance-control systems.***

Wind and weather have more influence on some of our missiles than on conventional weapons. Increases in range put both firing site and target locations at a premium. This requires special meteorological and survey equipment in addition to the electronic devices for detection and guidance purposes. These are difficult to maintain, hard to get.

● ***Mobility.***

Size always makes anything hard to handle and move. Two men can handle a footlocker. A piano takes a truck. The larger missiles limit the methods of transport available, or impose a requirement for new means. As an example, the Redstone booster container is 41 feet long and occupies a whole flatcar in transit. Road and rail nets without liberal side or overhead clearances may limit the selection of launching sites. The length and weight of most of these complicate the problems of handling and shipping, and require special field and unit equipment to maneuver and service.

● ***Storage and handling.***

Keeping missiles ready to fire is a storage headache. Some of the equipment must be kept at a certain temperature, some requires protection from even the smallest dust particle. In the case of Nike installations sited in populated areas, underground magazines are required to store safely the missile boosters. The limited numbers and strategic importance of these revolutionary weapons places a premium on the prompt supply of major items, repair parts and components.

● ***Fuel Supply.***

Liquid fuels are the most effective available power supplies for the long- and very-long-range missile systems. The special problems of handling and storage vary from highly corrosive acids to extremely low temperature liquid oxygen. This latter characteristic combines with a high rate of evaporation to require special plans for liquid oxygen or LOX supply in the field.

● ***Maintenance.***

Although there has been tremendous improvement in missile component reliability, and maintenance

requirements have been reduced by "throw-away" and "black box" combinations, trained technicians are needed all along the supply lines to perform the necessary maintenance and checkout steps. Some idea of the scope of this maintenance problem can be seen in the case of a Nike battalion. Each battalion requires many specially trained troop technicians. Of these, 38 are school-trained specialists. In addition, special Ordnance direct-support units are required to provide maintenance not within tactical unit capabilities.

- ***Requirements for missiles vs. recoil weapons and ammunition.***

In determining our needs for missiles, it is necessary that we carefully weigh their characteristics against the advantages of the conventional recoil weapon. For those ranges where surface-to-surface missiles parallel that of artillery, the choice of a missile appears to be justified predominantly by the fact that the individual *packages* in the system are smaller, and thus more mobile than some of our heavier artillery. In those situations where the mobility of the missile system is not the controlling factor and the recoil weapon can perform as effective a job, the re-supply drain on transport and other logistic considerations may well dictate the employment of "conventional" weapons with equivalent warheads.

For some time to come, *available types* of warheads may dictate employment of missiles despite the re-supply problem.

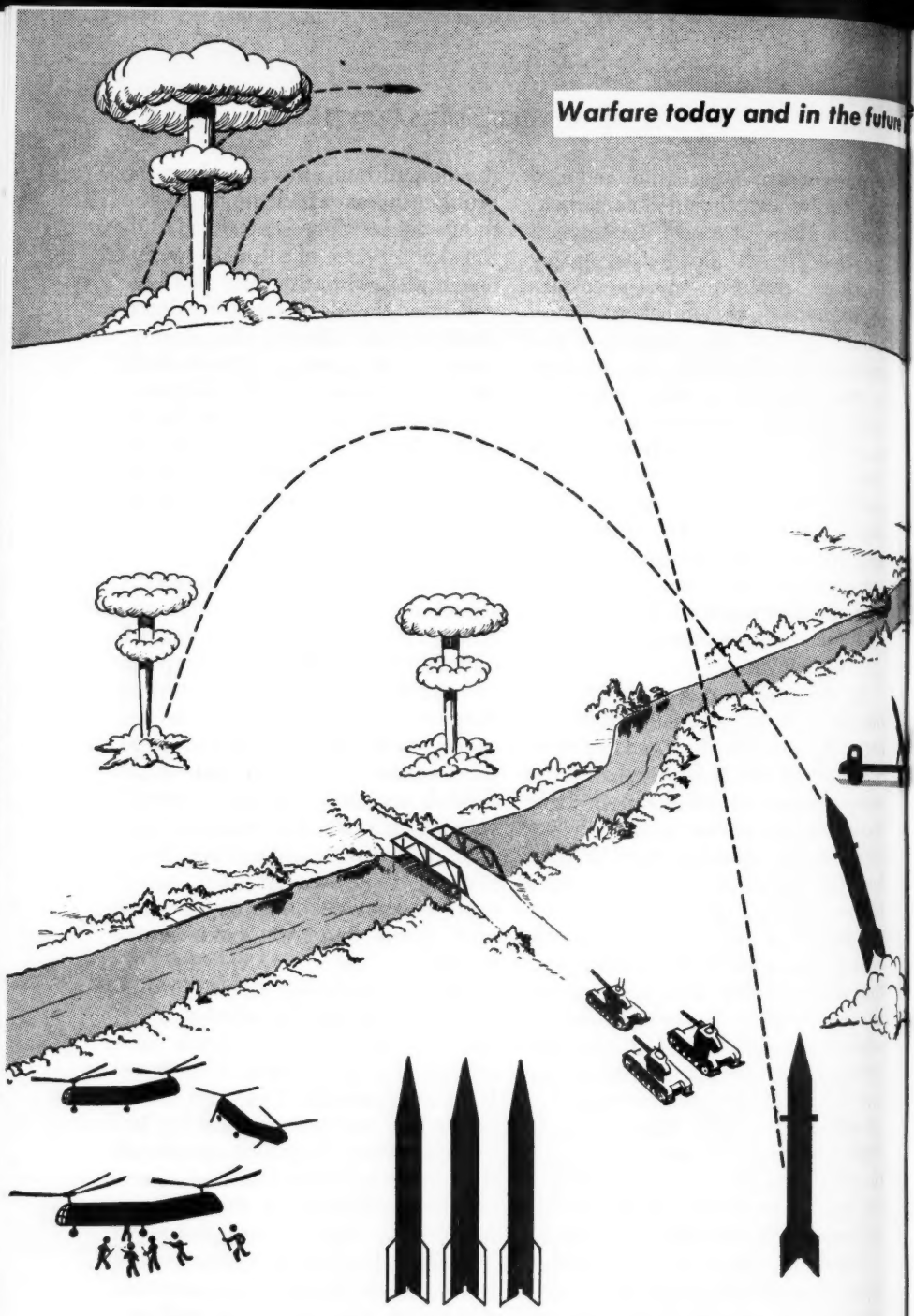
AS IN most discussions related to the impact of one thing or another, this one has tended to stress the difficulties. However, it is the problem areas which point up the things to be done—not the pie-in-the-sky aspects of ultimate weapons, both pushbutton and painless.

While the long-bow rendered obsolete the knight in shining armor, it did not in its day similarly affect the horse nor the firepower and mobility of a man on horseback. The problems posed by the military weapons revolution can be solved, but not by easy generalizations.

IT IS to the specific problems stated above that the Army Logistics System—from the Deputy Chief of Staff for Logistics in the Department of the Army, to the Technical Services and their Schools—is devoting itself. New MOS courses in the Ordnance, Engineer and Signal Schools are well underway. Special training courses for military and civilian industry alike have been started. Special logistical troop units to provide essential back-up and direct support have been created.

Many of these are already in the field, serving with the combat units they support. Special depot and movements procedures also have been established. The aim is to create and maintain a working industry-military logistical system at the same time as, and indeed ahead of, the availability of the weapon for combat. This is being done.

Before all thinking military men is the responsibility to evaluate the nature of this potential military revolution and prepare for it. The art and principles of war remain unchanged. The logistic problems, too, may not be *new*—they'll just be *different*.



". . . No longer are ground units restricted by the limitations of conventional weapons which formerly focused the army commander's attention on that enemy with which his forces were in direct contact."

Impact of Missiles On Tactical Doctrine

General W. G. Wyman

DEVELOPMENT of the guided missile provides the Army a source of firepower whose capabilities are more appropriately measured in miles and kilotons rather than yards and rounds per minute. This drastic extension of the Army's striking force tremendously expands the role of the Army in today's and future warfare. No longer are ground units restricted by the limitations of conventional weapons which formerly focused the army commander's attention on that enemy with which his forces were in direct contact.

The doctrine to guide an Army equipped with guided missiles and nuclear warheads must match in scope and flexibility the war-making means now provided by atomic missiles. Of equal and vital importance, this new doctrine must consider the threat established by the enemy's possession of a similar missile capability.

In any adjustment of Army doctrine necessitated by the impact of guided missiles, one must first consider the Army's primary mission of being capable of promptly initiating and subsequently sustaining land combat operations. The basic objective of land warfare is to destroy the armed forces of the enemy. Guided missiles carrying nuclear warheads are an optimum means for accomplishing such a mission. Enemy targets, however, will vary in size, composition, and importance, thus demanding skillful application of guided missile and other firepower to achieve maximum effect.

SINCE it is the capabilities of the missile weapon which dictate a re-evaluation of tactical doctrine, the time frame for application of such doctrine must be specifically defined in terms of the Army missile systems already operational, and those missiles currently being developed. Any concepts ventured beyond this period into the satellite era may involve doctrine which amounts to pure speculation.

The missiles which so greatly influence Army doctrine fall into two major categories—surface-to-surface missiles (SSM) and surface-to-air missiles (SAM). Both are considered artillery weapons, with increased range and lethality. The Field Artillery missiles (SSM) include the Lacrosse, Corporal, Redstone, Jupiter, Honest John,

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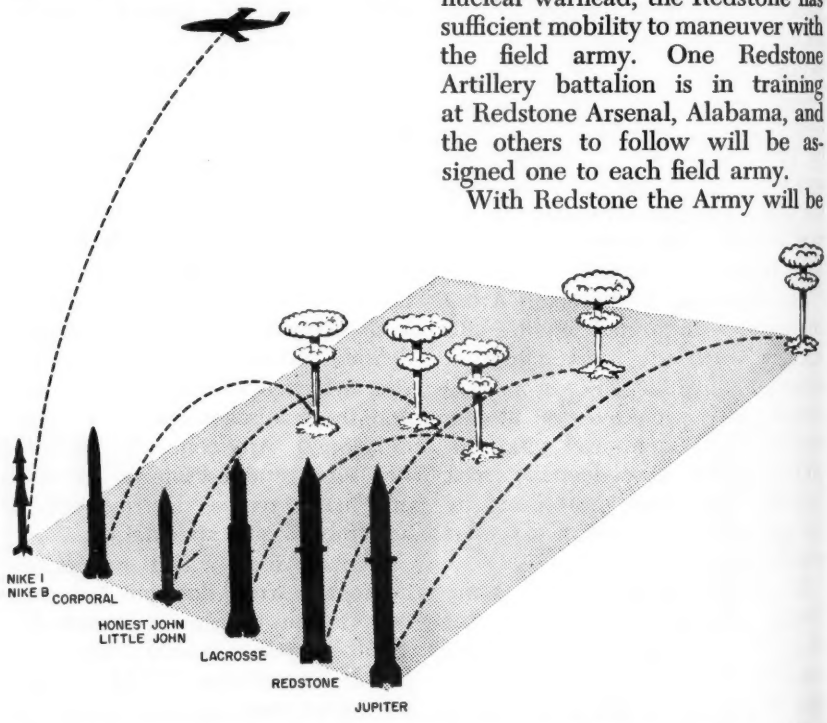
and Little John. The antiaircraft missiles (SAM) include the Nike I and Nike B.

The Corporal missile has been in the hands of troops since 1953. Corporal battalions have taken their places with the Army in the field and offer a ready capability for delivery of an atomic warhead on targets many miles from the launching sites. In the light of larger missile capabilities, the Corporal is considered a short-range missile. Field Artillery missile battalions (Cpl) are assigned on the basis of three per field army, thus making available to the corps commander a mobile weapon which can deliver for him in one missile the firepower equivalent to thousands of tons of conventional artillery ammunition.

The Corporal can deliver supersonic, surprise devastation on targets which may be immune to attack by aircraft because of weather or antiaircraft defenses. Its firepower is under exclusive control of the army commander and is employed to fire on any target within its range which threatens completion of the Army's mission.

Already in an advanced state of development is the Redstone Field Artillery missile. Its range capability is a multiple of the Corporal's. In spite of its large size and capability of carrying a thermonuclear warhead, the Redstone has sufficient mobility to maneuver with the field army. One Redstone Artillery battalion is in training at Redstone Arsenal, Alabama, and the others to follow will be assigned one to each field army.

With Redstone the Army will be



". . . The guided missile proved the Army has a source of firepower whose capabilities are more appropriately measured in miles and kilotons rather than yards and rounds per minute."

able to strike deep behind the area of contact on enemy targets, such as large reserve troop concentrations, airborne marshalling areas, airfields, communications centers and other targets of importance to the Army's operations.

Also in an advanced development stage is the Lacrosse Field Artillery missile. This new surface-to-surface guided missile will be capable of furnishing close support fires to extend and supplement conventional artillery. In its development, emphasis has been placed on accuracy and mobility.

Lacrosse artillery battalions will be assigned as corps artillery and because of their excellent mobility and precise accuracy may be included in future division artillery organization.

PERHAPS the most important of all Army surface-to-surface guided missiles under development is the Jupiter Intermediate Range Ballistic Missile. While not primarily an intercontinental missile, its range of approximately 1500 miles will allow it the capability of reaching targets deep in the heartland of any potential enemy country. The Jupiter will have sufficient ground mobility to maneuver with the field army. Jupiter Field Artillery missile battalions may be assigned to army groups, and in some situations may be employed at theater army level.

With the Jupiter missile the Army will be able to strike massive blows on any ground target retarding the completion of the Army's tactical mission. Final development of the Jupiter will bring to an end that period of modern warfare in which it has been necessary for the ground commander to depend entirely upon aircraft to extend the range and power of his artillery. Employment of the Jupiter will allow the air forces to devote greater strength and effort to winning the battle in the air. Through its range and devastating destructive power the Jupiter can attack distant troop concentrations, marshalling areas, and communications centers and will destroy or make untenable enemy missile sites, atomic stockpiles, and airfields from which the enemy can now conduct air operations against the Army in the field. Thus it will force enemy air to operate from bases greatly removed from the areas of contact.

THE missiles considered thus far have been truly guided missiles. To complete the Army missile family, the free rocket must be included as an important member. While inherent inaccuracies make free rockets infeasible at intermediate and long ranges, their very simplicity and reliability enhance their stature in a short-range role.

As general support artillery, the Army has developed and is improving the Honest John free rocket. Mounted upon a self-propelled launcher, this missile packs a tremendous atomic punch. Honest John artillery battalions are now integrated into the Army organization in Europe and Far East, thus placing in the hands of army commanders highly reliable and effective atomic fire power.

A little brother for Honest John called Little John has been conceived by the Army and is being nurtured to maturity. A much smaller version of the free rocket,

". . . From widely dispersed positions, relatively small, mobile, independent, self-sustained fighting elements must mass rapidly together, execute a mission, and disperse once again as soon as possible."

its launcher will be helicopter-transportable and its rate of fire substantially increased over that of Honest John. Little John is expected to be an ideal artillery support weapon for airborne operations. Upon full development, it will have distinct possibilities in reinforcing corps and divisional general support weapons.

The Army's surface-to-air antiaircraft artillery Nike missile has been developed to the point where it is now the major bulwark of the antiaircraft defense of the United States. It will next be placed with the field army to give the army commander a missile antiaircraft capability with deadly kill probability against any known operational enemy aircraft. Nike antiaircraft artillery missile battalions are now on site in force and ready twenty-four hours a day to destroy invading enemy aircraft. In the field army, one of Nike's vital missions will be to protect SSM launching sites, just as conventional antiaircraft artillery now protects conventional field artillery.

A larger member of the Nike family, Nike B, has reached an advanced stage of development. Its much increased range, plus the ability to carry a more powerful warhead, when integrated with antiaircraft defense, is expected to provide a significant improvement in the antiaircraft artillery defense against enemy air attack, both in continental United States and in the field army.

In addition to the above missile families, two other significantly important missile requirements exist. A reconnaissance type guided missile for collection of intelligence and target acquisition will be

essential, and an anti-missile missile will become a necessity to seek and destroy enemy long-range missiles while in flight.

THE VAST increase in range capability and destructive power available to the Army through missiles obviously requires changes in tactical doctrine to insure the effective employment of these magnificent weapons. It must be assumed, also, that the enemy will have missiles of at least equal capabilities. Thus, our tactical doctrine must likewise provide for minimum vulnerability to these enemy missiles. It becomes apparent, then, that first and foremost our Army must organize the battlefield for survival in spite of enemy atomic missile strikes. Flexibility of organization accompanied by increased troop and firepower mobility offer the best practical solution.

Since the principle of mass for decisive action is directly opposed by the necessity for dispersal of forces as protection against atomic missiles, these two principles can only be made compatible in the guided missile era by drastically increasing the mobility of combat units of the field army. From widely dispersed positions, relatively small, mobile, independent, self-sustained fighting elements must mass rapidly together, execute a mission, and disperse once again as soon as possible. Division organizations should contain several of these battalion-sized, balanced combat elements so that the annihilation of two or more will not destroy the combat effectiveness of the entire division. Our Army artillery missile units themselves will require 100 percent mobility. Any fixed or long-occupied launching site will soon cease to exist as the result of enemy missile attacks.

The wider and deeper the Army battle area becomes, the more difficult become control, communications, and logistical support. Radio communication will become the primary means employed in the combat elements of the field army. Tactical television screens receiving coverage from drone Army aircraft or drone missiles will be necessary to allow the army commander to follow the battle and to control his fighting units. The extensive land area covered by the dispersed elements of a field army will make mandatory the employment of Army cargo helicopters and fixed-wing aircraft to perform logistical support missions throughout the battle area.

Attainment of the capability to strike deep enemy targets approximately 1500 miles from the Army area of operations must be accompanied by a parallel capability to acquire targets at the same range. The Army recognizes this problem and much improvement must be made in our target finding capability. Army observation aircraft offer an early remedy to this dilemma, while a drone reconnaissance guided missile offers the best ultimate solution.

Another tactical problem in coordination has been made more difficult by the impact of guided missiles. Some of the Army's new missiles fly higher than the maximum ceiling of any known aircraft; therefore, missiles may not be fired indiscriminately through the air space over and forward of the Army area. Both Army and Air

Force aircraft must have sufficient warning to insure their absence from the trajectory path of any missile to be fired. Hence, for ease of coordination between aircraft and missile, it becomes mandatory for the ground army commander to control the air over his area of operations to the extent of the range of his organic and attached supporting weapons.

THE ARTILLERY tactical doctrine of direct support has been and will be further affected by the advent of missiles. Whereas it is certain that gun type antiaircraft will soon be largely replaced by missiles, it is not yet clear that missiles will entirely replace gun type surface-to-surface artillery. At least for many years to come, the two will be complementary. Conventional artillery doctrine provided organic eyes and ears for target getting and adjustment of artillery fire in the form of observation aircraft and forward observers. Only one artillery missile unit, the Lacrosse battalion, will have forward observers, and none will have organic aircraft. As a result, the targets must be acquired by means outside the control of the missile delivery units.

The acquisition and analysis of guided missile targets and the transfer of target information to the artillery firing unit, when added to the preparation of the firing data, missile, and warhead, result in such a considerable lapse of time that the so-called "target of opportunity" cannot be truly said to be subject to attack by missiles in general except, of course, in the case of antiaircraft missiles. Consequently it is imperative that em-

". . . Our Army artillery missile units themselves will require 100 percent mobility."

phasis be placed upon development of improved doctrine and staff procedures in the field army to achieve the minimum time between the appearance of an appropriate missile target and delivery of fire upon it.

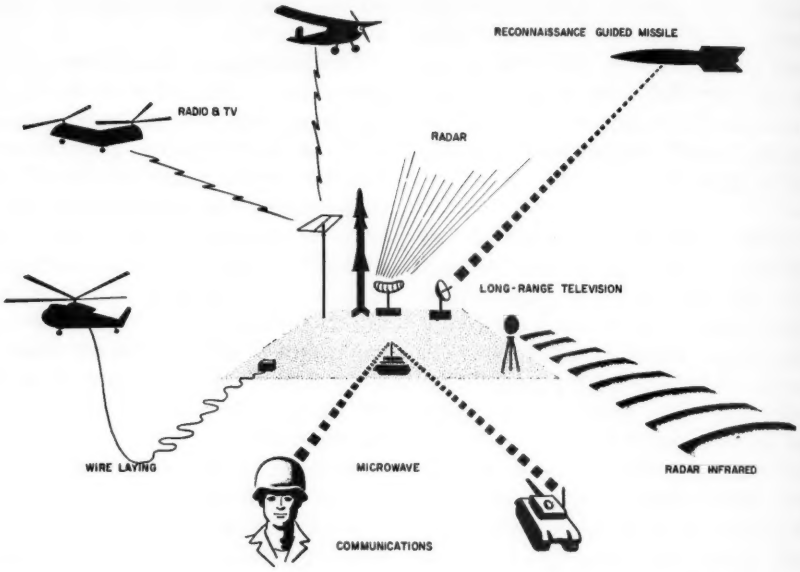
THE tactical organization of artillery firing units themselves has also felt the impact of guided missiles. Large, short- and relatively long-range missiles such as Corporal, Redstone and Jupiter with relatively slow rates of fire have no requirement for more than one or two firing sections and launchers per firing unit. Logistic support in the form of fuels, maintenance, and spare parts, simply cannot be maintained for additional firing elements, nor does the firing unit have the capability of assembly and checkout of sufficient missiles and warheads to require employment of more than one or two launchers. Missiles with range capabilities more nearly equal to conventional artillery weapons, such as Lacrosse and Honest John, are organized into four launcher fire units. However, these, as well as those longer range missile units previously mentioned, have only one firing battery per battalion, thus actually making the battalion the basic guided missile fire unit.

In addition to the logistic support and sustained rate of fire aspects, there are other reasons for this reduced-size, single-fire unit battalion. No requirement exists for the extensive massing of fire from a number of pieces as in conventional artillery. One missile fired with an atomic warhead carries the destructive force equivalent to a volley from hundreds of artillery pieces firing high explosive ammunition.

Further, greater flexibility of employment is attained with the small battalion organization rather than with a cumbersome three-firing-battery organization deployed in such widely dispersed battery positions as to make control extremely difficult. A final and very pertinent reason is recognition of the desirability for having a relatively senior experienced artillery officer directly in command and supervision of the major firepower elements of the field army.

Because of the range capability of the Nike antiaircraft missile, a change in tactical doctrine for antiaircraft defense of the army area is expected to be implemented. Instead of protecting specific critical units and installations by setting up optimum gun rings, employment of Nike will permit a checkerboard type arrangement of Nike fire units to furnish over-all protection for the entire army area. Defense of the entire army will be controlled from a centralized antiaircraft artillery operations center under command of the army air defense commander.

With the attainment of a Nike B capability in the field army, two problems relative to doctrine for employment evolve because of its great destructive power. The first, of course, is the increased necessity for coordination with friendly air forces prior to firing. The second is the troop safety problems involved in firing its warhead over ground troops. The former must be solved in a manner similar to the related problem of coordinating surface-to-surface missile fire with aircraft flights, as discussed above.



"The wider and deeper the Army battle area becomes, the more difficult become control, communications . . . Tactical television screens receiving coverage from drone aircraft or drone missiles will be necessary . . ."

Solution to the second problem will depend upon the size warhead developed for employment with the Nike B missile system.

PERHAPS the most significant result of the development of a long-range antiaircraft artillery missile of great destructive power will be the beginning of the end of the ability of the enemy to deliver a knockout blow to continental United States or the Army in the field by means of bomber aircraft. The kill capability of an organized and adequate Nike B missile defense will be of such effectiveness that a substantial portion of our military force and industrial power can be expected to survive and fight even if the enemy strikes first. Enemy losses will be so heavy as to preclude immediately heavy follow-up strikes, and bomber striking forces will eventually be decimated to the point of ineffectiveness by antiaircraft missile defenses.

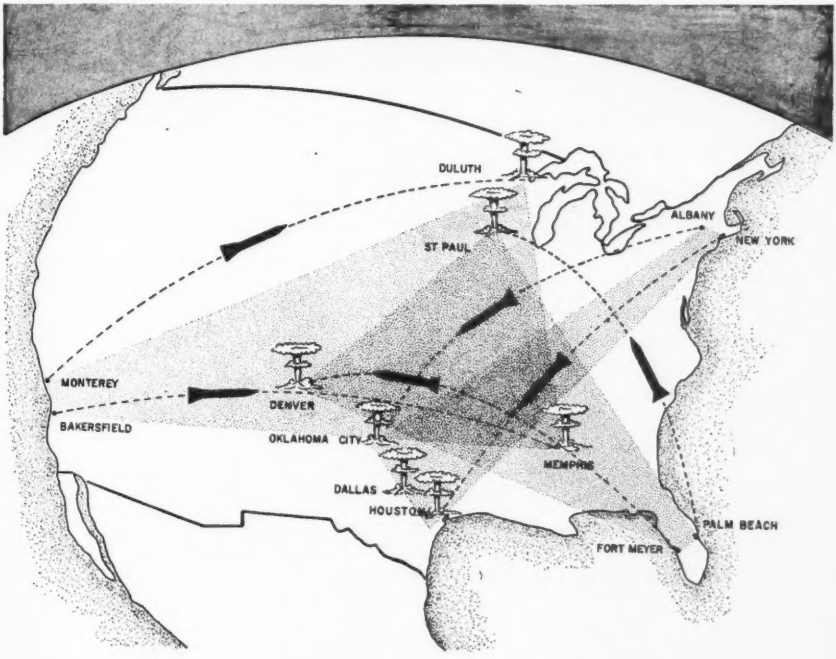
In the evolution of thought concerning tactical doctrine as affected by guided missile capabilities and limitations, two appealing and somewhat related avenues of approach are in reality only dead-end streets. The first involves the tempting idea that the intermediate range missiles such as Jupiter have no urgent requirement for positive ground mobility, but instead can be operated from elaborate fixed sites chosen for their convenience to expected enemy targets. Nothing could be more fallacious.

Fixed launching sites for missile fire support of a field army will be the Maginot Line of modern atomic warfare, and will be of little but

historical value after the first bombardment by enemy air or missiles. All missile units planned for the field army, as well as those logistic units which support them, will be dependent on their ground mobility for survival and accomplishment of their support missions.

The other result of wishful thinking conceives the idea that guided missiles represent the absolute weapon, that the missile with atomic warhead is a panacea for any other tactical shortcomings of the Army. Such conclusions, of course, must be discarded. Missiles cannot capture, occupy, and defend terrain. People alone will always retain this capability so vital to the mission of the Army. The most to be required of the missile is that it provide powerful, flexible, and far reaching support of Army operations in the field.

The extent of surface-to-surface Field Artillery missile fire support capabilities now under development for the Army can be illustrated as follows: A field army supported by a Jupiter artillery unit and operating in the Albany-New York City area could destroy targets in the southwest United States as far as Houston, Dallas, and Oklahoma City. A field army fighting on the Florida peninsula could eliminate military concentrations in Minneapolis, St. Paul or Denver. Similarly, the fire support capabilities of a field army in California



The extent of surface-to-surface Field Artillery missile fire support capabilities now under development is dramatically illustrated in terms of United States geography.

could place devastating atomic fire on appropriate targets as far away as St. Louis, Memphis, or Duluth.

DEVELOPMENT of the guided missile and free rocket capable of carrying the atomic warhead is dictating a veritable revolution in tactical doctrine for the Army. The enemy atomic missile threat will require broad new concepts for deployment of the field army. Extensive reorganization of the elements of the field army is necessary to insure accomplishment of its mission. This is being done.

The principles of war will not be altered by the coming of the missile, but their successful application is made far more difficult. The range and fire power of atomic missiles have deepened and widened the battle area. The army commander's ability to influence the success of his mission by supporting fires has been vastly increased. However, missile firepower will avail little to the Army without sufficient mobility, adequate communications and simple logistic procedures.

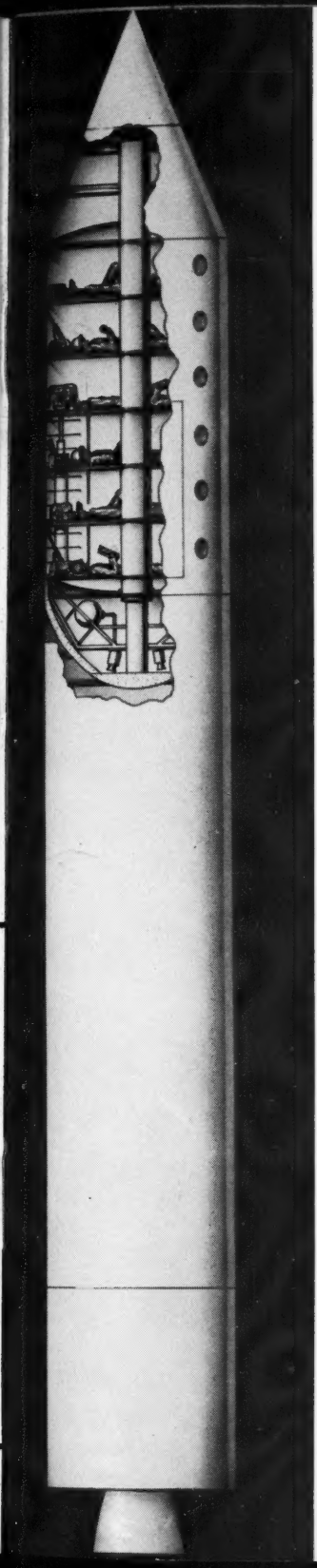
The impact of the atomic missile on tactical doctrine must be thoroughly impressed upon all personnel in the Army. Our Army schools must be the fountainhead from which spring the required new principles and procedures. The importance of maximum integration of guided missiles and atomics into the programs of instruction in our Army schools cannot be overemphasized.

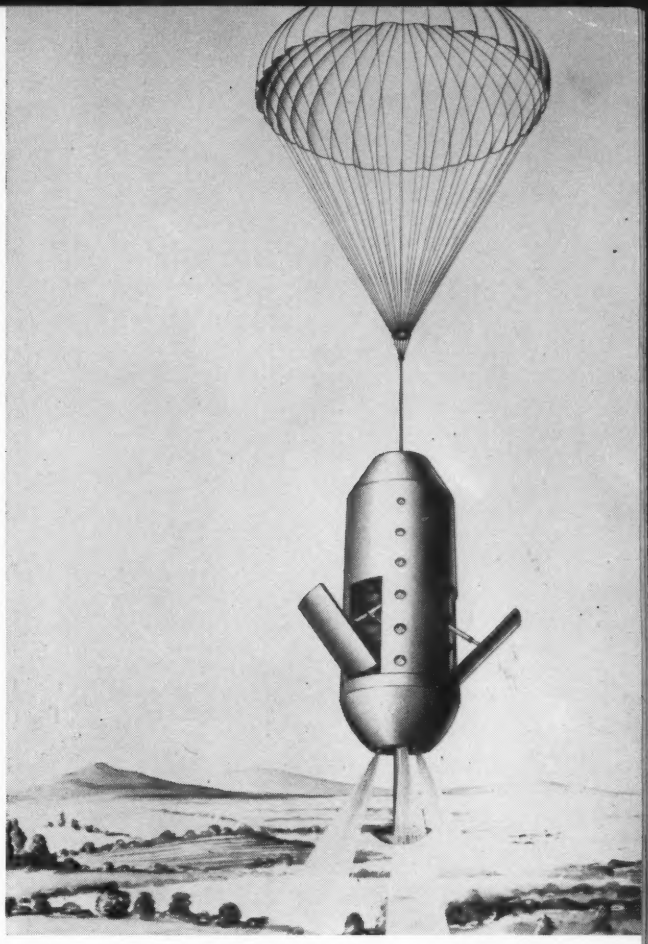
The great new Army capability represented in the family of atomic missiles must be thoroughly exploited with a constant view toward increased effectiveness in battle. Success or failure in this task may mean the difference between survival or destruction of our Army and the United States.

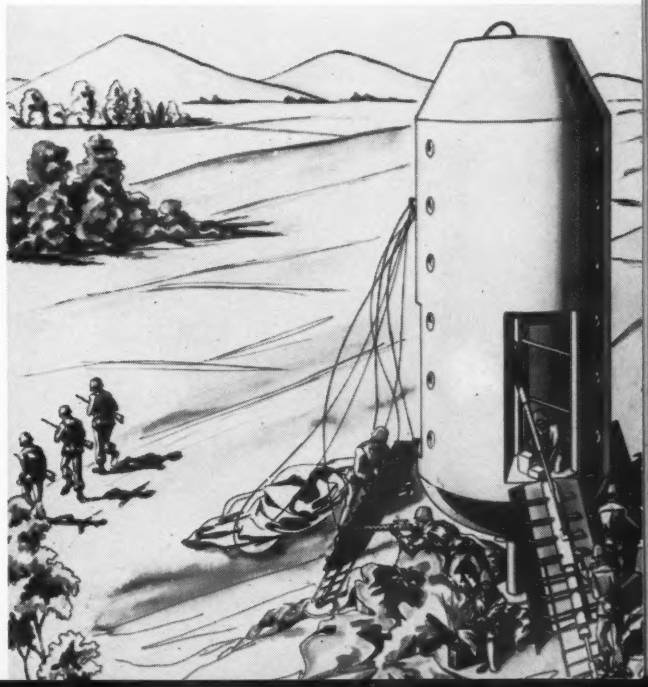
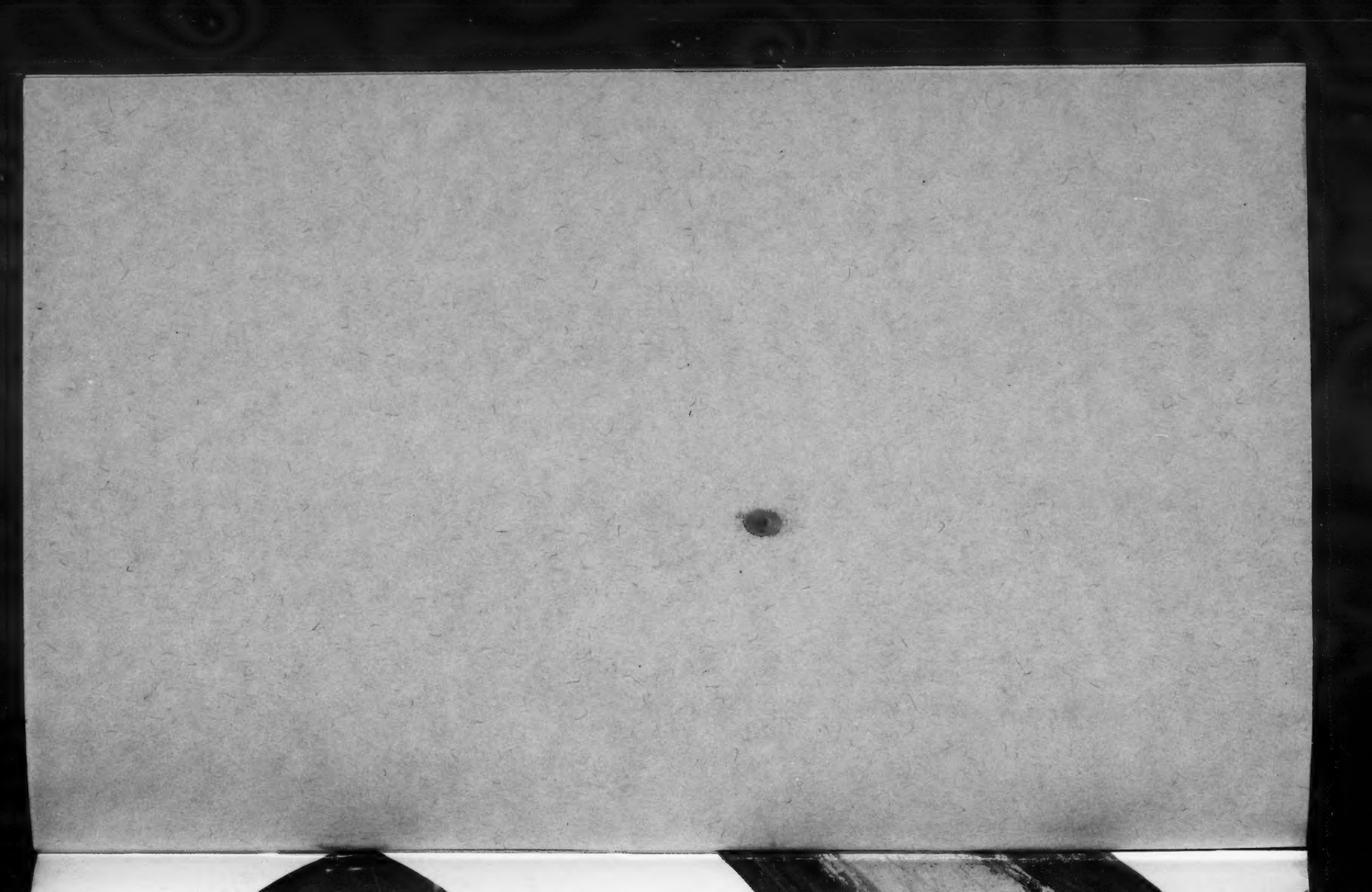
Missiles--Troop Vehicles of the Future

ADDRESSING the recent convention of the Association of the United States Army, Lt. Gen. James M. Gavin, Chief of Army Research and Development, stated: "What has been accomplished thus far has brought still more distant horizons into sharper focus. Military concepts once identified only as futuristic fantasies have begun to take on meaningful substance and shape. . . . The day will come when the missile form itself can serve as a means of transport."

Carrying this concept still further, Major General John B. Medaris, Commander of the Army Ballistic Missile Agency, declared that "the time has arrived to consider them [missiles] as the most advanced, the most efficient delivery system which can be predicted." Illustrating this thesis are the sketches at right. A troop-carrying missile (*left*), launched from a friendly base towards an objective 500 nautical miles distant, would be slowed by rocket motors as it nears its destination. A parachute (*top right*) might also be used to brake the descent. Upon landing (*bottom right*) troops and supplies would debark to take up positions at critical control points.



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